

**TOWARDS THE DEVELOPMENT OF AN EARLY WARNING
SYSTEM FOR THE IDENTIFICATION OF THE STUDENT AT
RISK OF FAILING THE FIRST YEAR OF HIGHER EDUCATION**

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To

Glynn and Richard

with love and gratitude

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ABSTRACT

The purpose of this study was to use first-year test results to develop an early warning system for the identification of freshmen at risk of failing.

All students registered between 1989 and 1997 for the six-year programmes chiropractic and homoeopathy were included in this *ex post facto* study. A descriptive study firstly indicated a serious problem of attrition with on average only 66% of chiropractic and 55% homoeopathy freshmen successfully completing the first year.

A relationship was demonstrated between both first and second test results and outcome at the end of the first year of studies. A logistic regression model estimated retrospectively from first test results in physiology, anatomy, biology and chemistry was able to discriminate between successful and non-successful freshmen with an overall predictive accuracy of 80.82%. When this model was validated on a different set of data it was shown to have a very high sensitivity and was thus able to correctly identify >93% of the potentially at risk freshmen. It also had a low Type II error (<7%) and thus missed very few of the freshmen at risk of failing.

A logistic regression model estimated retrospectively from second test results in physiology, anatomy, biology and chemistry had an overall predictive accuracy of 85.94%. The validated model had a sensitivity of 67% which was too low for the model to be of much use as a management tool for the identification of the freshmen at risk of failing. However, the model was shown to have a high specificity and was able to correctly identify >93% of the potentially successful freshmen. It also had a low Type I error (14.29%).

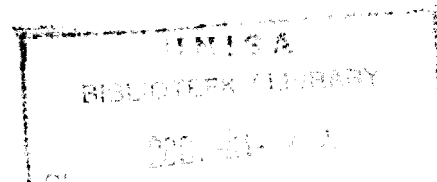
Discriminant analysis models estimated from both first and second test results in physiology, anatomy, biology and chemistry produced strong support for the use of test

results for the early identification of those freshmen who would need support in order to be successful.

It is suggested that the objective models developed in this research could identify the freshman in need of support at an early enough stage for support measures to still have a positive effect on attrition.

Key terms:

Attrition; First-year students; At risk students; Early identification of at risk students; Early warning; First year test results; Academic outcome; Successful; Dropback; Academic exclusion; Academic performance.



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CHAPTER ONE

INTRODUCTION

1.1 IDENTIFICATION OF THE PROBLEM

1.1.1 BACKGROUND TO THE INVESTIGATION

In the present socio-economic climate in South Africa it is becoming increasingly difficult to subsidize students at tertiary level and high dropout and failure rates can no longer be afforded. With student selection procedures and retention rates coming more and more under the spotlight, a very challenging situation exists for academic managers. Whilst State funding is being linked to student success, and with all academic departments expected to show economic viability, the temptation exists to select only those students that will have a fair chance of academic success and completion of their studies. As students from less advantaged academic backgrounds cannot compete with those from more advantaged backgrounds when it comes to normative selection processes, the selection of students with a better chance of passing would discriminate against disadvantaged students and such a procedure would be directly against all attempts to redress the imbalances of the past. Against this background, heads of academic departments are expected to very rapidly change the demographic profiles of their departments.

Fourie and Naude-De Jager (1992) pointed out that the majority of future students in South Africa would be black and that important aspects of educational management such as student selection at tertiary institutions and also the identification of students at risk of failing their tertiary studies would have to be geared towards the unique requirements and demands of black students.

Against this background it must be remembered that resources and infrastructure at all levels of education are already being stretched to the limit and tertiary institutions are being pushed away from State funding towards private funding with an ever increasing emphasis on efficiency and accountability.

In the light of the financial crisis that exists in South African tertiary institutions, good financial management of the available resources becomes critical (Gourley 1992). The already serious financial problems experienced by tertiary institutions must also be seen against the compounding factor of their social obligation to provide tertiary education for the previously disadvantaged students. No simple solution for achieving this ideal exists. Fundamentally the solution lies in equalizing standards of education and learning at schools to prevent a student from becoming socially and academically disadvantaged, but four years after the transition to a democratic system there is unfortunately still no sign of a successful transformation in the education system in South Africa.

Underprepared students present an enormous problem to South African tertiary institutions. Whilst the previously disadvantaged students are clamouring for higher education, it will be unfair to admit them to inferior courses simply to allow them entrance into "higher education". Real equity in higher education implies that quality education will be allowed to all. Increasing entrance requirements and denying access to underprepared students (Grobler 1993) cannot ensure quality. Until the implementation of an equalized school system, short-term solutions are therefore required. Moreover, what is becoming very clear is that tertiary institutions will have to change their approaches completely in order to admit, cope with, and support these previously disadvantaged students towards the development of their full academic potential.

However, should tertiary institutions embrace their social obligation by a decision to change their student demographic profile, they must do so on the basis of an enlightened understanding of the increased cost of this undertaking. It is well documented (Fourie & Naude-De Jager 1992; Mitchell *et al.* 1994; Ferreira 1995; De Villiers & Rwigema 1998; Botha & Cilliers 1999; Dawes *et al.* 1999) that students from disadvantaged academic

backgrounds experience greater difficulties in adapting to the tertiary education system and in being successful in their tertiary studies. Simply admitting disadvantaged students and then not supporting them adequately is unethical and leads to enormous wastage. Every student “lost” from a programme represents a waste of a career opportunity. According to Bullimore (1992) students who fail to complete are a triple tragedy. Firstly, there is the waste of effort and self-esteem to the student. Then there is the anguish of the student who was displaced from entry into the programme. Finally, there is the considerable financial loss to the tertiary institution, which is often already in serious financial difficulties. To this must also be added the fact that student attrition adversely affects the morale of the remaining students and staff.

Although historically disadvantaged tertiary institutions postulate that their financial burden is greater regarding the provision of quality higher education to disadvantaged students (Wood 1998), all tertiary institutions will have to understand that they have responsibilities towards the students that they admit into their programmes. This includes a focus on the cognitive as well as the non-cognitive development of the students, and particularly of the disadvantaged students, as well as on the financial implications of the necessary support and development programmes. It must be understood very clearly that it is the entering student who has been affected by the previous academic inequity and it is this student who will have to be nurtured and supported. The financial implication per student will be the same wherever the student elects to study, be it at a historically disadvantaged or historically advantaged institution. Tertiary institutions will therefore need to quantify the cost of such support and work that into their strategic plans - not only for the supply of support staff, but right down to extra academic staff and tutors in the academic departments where they can really make a difference in the retention rates of students. The cost of staff development to improve the lecturing skills and approaches to teaching of existing and new lecturers will also have to be included in the budget.

Large numbers of underprepared students added to the existing student population at tertiary institutions would certainly add to problems of non-completion or student attrition. In order to do effective financial planning, managers at tertiary institutions are

reliant on a comprehensive management information system (Gourley 1992).

Educational management principles dictate that, per programme, an institution should quantify the problem of attrition, identify the student at risk, and implement measures to retain as many students as possible by supporting them to become successful in an atmosphere of academic quality.

The problem of student attrition or non-completion rates appears to be serious and is of critical concern to all tertiary institutions, not only in South Africa, but also around the world. While there have been many studies reporting “predictors of success” in tertiary education (e.g. Arnold *et al.* 1983; Sear 1983; Lazarus & Van Niekerk 1986; Nettles *et al.* 1986; Foy & Waller 1987; Touron 1987; Fulton 1988; Barker 1989; Johnes & Taylor 1989; Montague & Odds 1990; Lazin & Neumann 1991; Shen & Comrey 1997; Dawes *et al.* 1999; Till 1999), few have looked at student characteristics that place students at higher risk for dismissal, delay, or academic difficulty.

In order to avoid student losses, or at least to minimize the percentage students lost, the problem must be quantified and remedial action sought. However, information about the numbers of students “lost” and their reasons for “withdrawal” is not widely available, whereas there is a paucity of evidence about whether there are indicators within the potential students’ written applications that may serve as a guide to future performance and attitudes.

Many institutions and sections such as medical schools (abroad as well as in South Africa) do not publish their attrition rates and therefore actual data are unknown. In the United States of America it appears to be routine for educational institutions to conduct studies of their rates of retention of students over time, whereas little consolidated research into non-completion rates is available for the United Kingdom. It appears as though a number of institutions might have conducted “in-house” surveys in recent years, but relatively little has emerged into print.

Student attrition deserves, in terms of sheer numbers, the attention of educational managers. As early as 1978, Pantages and Creedon calculated that only four out of every ten students who entered colleges in the USA would graduate from that college four years later. They also calculated that, of the number of students that enrolled per year in the USA, in excess of two and a half million would completely drop out of higher education (Pantages & Creedon 1978). If these figures are extrapolated to the present time and to include first-year students in the rest of the world, the sheer magnitude of the problem demands attention.

One area that has been given relatively little attention in studies is that of trying to establish the cost to public finances of students who do not complete the programmes of study for which they originally enrolled. In a recent study, Yorke (1998) attempted to quantify the costs to the public purse of undergraduate non-completion in England for the academic year 1994/1995. Although this study excluded teacher training programmes, as well as the Open University and the Universities of Oxford and Cambridge which the author defined as “atypical institutions”, and also one institution “grossly out of line in the reporting of non-completion rates” to the British Higher Education Statistics Agency, the cost to the public purse of the undergraduate non-completion in England for that single academic year amounted to £91.5 million.

It must also be remembered that the costs of non-completion are borne not only by the public purse and by the tertiary institutions, but also by the students themselves (many of whom obtained these funds from student loans with the added burden that the banks demand the start of the repayment process immediately after cessation of studies), and by sponsors such as parents, spouses and other donors.

The actual non-completion rates in South Africa also appear to be a reasonably well-kept secret by tertiary institutions, unless it is simply not seriously researched and quantified. Analyses of the studies that do mention pass rates, or alternatively non-completion rates, indicate that this problem in South Africa is also very serious. Todd and Raubenheimer (1994) reported that, on average, only 4% of students who registered for an Engineering

degree at Rand Afrikaans University completed it in the minimum of four years. An evaluation of all 549 students who registered in the Faculty of Engineering between 1982 and 1986 indicated that a staggering 72.3% of these students never completed their engineering programme. Ferreira (1995) reported that in 1980 nearly 30% of all registered pre-graduate students at Pretoria University left the university without completing their studies. A number of authors (Fourie & Naude-De Jager 1992; Mitchell *et al.* 1994; De Villiers & Rwigema 1998) also reported that the problem of non-completion in South Africa was very much higher for disadvantaged students than for historically advantaged students. Because of the significant investment that students and institutions alike make to studies in higher education, it is important to investigate the percentage students “lost” to the institution or the causal effects of such attrition.

A tertiary institution must be able to calculate the financial implications of enrolling a student in each one of the courses/programmes offered at that institution. State funding per student is increasingly being cut (Melck 1999) and cost per student needs to be carefully considered by the tertiary institutions. It must be remembered that non-completion students have the same financial implications to the institution as the successful students. Individual tertiary institutions must thus make informed strategic decisions, based on the information supplied by a comprehensive management information system (Gourley 1992), on whether they will support the “unsuccessful” students with costly support services. Once an institution has, however, formulated the acceptance of their social obligation to the previously disadvantaged students into a strategic decision to change the demographic composition of their student population, a complete change will have to occur in student selection procedures. At this stage they can at most try by means of their selection procedures to exclude “advantaged” students who are underprepared for tertiary studies and who will cost the institution much in resources and time. These selection procedures then cannot and indeed must not be used to exclude academically disadvantaged students from the institution.

The issue of relevant, fair and efficient student selection procedures has become a very real problem in South Africa. Although discussions about revised selection criteria have

been taking place at a range of universities (Skuy *et al.* 1996), the selection of students to tertiary programmes still appears to be done mainly on the basis of the candidates' matriculation marks in general and specifically in subjects that are judged to be of relevance to their chosen field of study (De Vetta 1993; Mitchell *et al.* 1994; Sawyer 1994; Ferreira 1995; Jawitz 1995; Louw *et al.* 1998; Zaiman *et al.* 1998; Dawes *et al.* 1999). However, as black South Africans have been subjected to significant educational disadvantage, their matriculation cannot be taken as a true reflection of their academic potential and the exclusive use of school marks as admission criteria might therefore lead to an unjustifiable exclusion of a significant proportion of black students from admission to tertiary institutions (Skuy *et al.* 1996).

Many students from educationally disadvantaged backgrounds are underprepared for tertiary studies, but then so also are many from so-called advantaged backgrounds. With the problems apparently occurring in the South African school system and made common knowledge in the press, this situation of underpreparedness for tertiary studies might become more serious over the next few years. It is becoming almost impossible to know the academic readiness of the students in any programme and research is urgently required in order to try and develop strategies that could guide heads of academic departments to help students, who are already in the system, over the first year hurdle. One of the ways by which this can be done is by the development of an early warning system to identify the first year student who is at risk of failing the year.

The first year of study seems to be a particularly difficult and dangerous time. If one could identify the student at risk early enough, remedial work could be started immediately and might "save" the student. If the remedial/support action does not have the desired effect and it is still early enough in the year, one could even suggest a split first year in that the student reduces his subject load together with receiving support in areas such as approaches to learning. However, it is important that the decision to request students to split their first year must be taken as objectively as possible and be supported by research results, otherwise students (particularly black South African students) could see it in a negative light as discrimination. The practical value of a

method of early detection of the student at risk and advice to split the course during the first semester takes away the necessity for a head of department to give such advice before the start of the year. In practical terms this means that the student is first given an opportunity to attempt the year and his/her own performance will determine whether he/she moves into the slow stream or not. The advantage of such a model would be that one would not have to voice an opinion on a student's chances of passing or not, because telling people in advance that they belong in a slow stream could quite easily become a self-fulfilling prophecy.

1.1.2 STUDENT ATTRITION AT TECHNIKON NATAL

Apart from the relatively simple way of reporting pass and/or failure rates according to individual subjects which gives no true indication of failure rates or non-completion rates, and in fact underreports grossly on these figures (Sawyer 1994), no other published results are available at Technikon Natal. At Technikon Natal no institutional attempt has yet been made to quantify attrition, or non-completion rates.

Of specific interest to the researcher are the two programmes chiropractic and homoeopathy offered at Technikon Natal. Both these programmes appear to have a high attrition rate as well as the following additional factor which renders the cost to all parties of even more concern. Whilst the calculation of non-completion rates in other programmes, both in South Africa and abroad, cannot be viewed simplistically as "wastage" because some students might have left tertiary institutions with intermediate qualifications such as a Certificate, or with credits that could be transferred to another field of study, this is not so for these two programmes. Most health programmes such as chiropractic, homoeopathy, medicine, physiotherapy and others are presently structured in such a way that credits are not transferable. Moreover these programmes have a first exit point that is after a very long period of study. For chiropractic and homoeopathy the first qualification awarded is at the end of six years of study. Any student who leaves the programme before completion, does so without any qualification whatsoever. There are

many excellent reasons for this phenomenon which is particularly true for the health field, such as the possibility of “underqualified” health personnel treating patients without having completed the full programme. The patient’s health and safety must come first, but for non-completing students in these fields, “wastage” becomes an appropriate term. Students who leave any of these programmes before completion would certainly also be disadvantaged in the labour market due to the very specialized nature of their studies which does not equip them for work in many other fields. All non-completers would have to start “afresh” in another field of study whilst they already carry the heavy financial burden of their first attempt.

Until 1989 it was not possible to qualify either as a chiropractor or as a homoeopath in South Africa and all students who wished to do so had to go overseas to train. In January 1989 Technikon Natal took the lead in South Africa by starting both these educational programmes at the same time. Apart from two subjects in the third year of study, these two programmes are identical for the first three years and also very similar to conventional medical courses as offered at most medical schools in South Africa. The names of the subjects might differ from those at medical school, but the content and application are very similar. The first three years consist mainly of the basic sciences (the pre-professional studies) with two clinical subjects included in the third year and with the fourth and fifth years of study devoted mainly to clinical studies. As the students qualify with a Masters degree, part of the requirements is the completion of a research project and dissertation. In their fourth year students complete a course in Research Methodology and Statistics and during their fifth and sixth years of study they develop a research proposal which they complete and write up as a dissertation. The sixth year is an internship year, spent mostly in the clinics on campus as well as in hospitals and in organized community service. After completion of all requirements, they are registered as practitioners with the Chiropractors, Homoeopaths, and Allied Health Service Professions Council of South Africa (CHAHSPC).

When it comes to health programmes, selection must surely be one of the major factors that will determine the quality of subsequent health care delivery. Students selected into,

for example, chiropractic, need many personal (inherent, non-cognitive) qualities that will help them become caring and concerned practitioners. It is very important, though, to also remember that these students would never be able to cope with the vast body of knowledge required for health care unless they also possess the cognitive ability to assimilate this extensive and complex material. A scrutiny of the selection procedures utilized at most medical schools indicated that, although additional selection methods such as the interview (Bullimore 1992; Collins & White 1993; Glick 1994; Edwards *et al.* 1996; Johnson *et al.* 1998), admission tests (El Mouzan 1992), personality profiles (Green *et al.* 1993a; 1993b), measurement of personal qualities, motivation and life experiences by structured or semi-structured interviews (Tutton 1993; Collins *et al.* 1995; Harasym *et al.* 1996) might be used, almost every medical school used these methods in conjunction with the attainment of a minimum acceptable academic standard (Bullimore 1992; El Mouzan 1992; Neame *et al.* 1992; Collins & White 1993; Green *et al.* 1993a; Green *et al.* 1993b; Tutton 1993; Powis 1994; Collins *et al.* 1995; Simpson & Budd 1996; Whitehouse 1997; Marley & Carman 1999). Where this academic threshold might be relatively lenient as at the Ben Gurion University in Beer-Sheva, Israel (Glick 1994), completely “open access” without such a minimum academic level might just be passing the responsibility to the basic science lecturers where selection takes place by “dropout” - a very wasteful procedure (Walton 1994).

As far as access is concerned, technikons (tertiary institutions similar to technical universities and institutes of technology) require only a Senior Certificate pass whereas universities in South Africa require a Senior Certificate plus a matriculation exemption as explained under point 1 below (SA. Department of Labour 1998). This lower minimum academic threshold does open up the tertiary education opportunities to many more prospective students, but at the same time it raises many questions about selection. How does one decide who should be accepted into a course from the vast numbers of applicants? Most departments at technikons therefore set their own (higher) selection criteria. For entry into either the chiropractic or homoeopathy programme a student is expected to have a matriculation exemption pass as well as passes in mathematics and/or physical science and preferably also in biology.

At present students are selected according to the following criteria as set out in the individual Departmental Handbooks of the Department of Chiropractic and the Department of Homoeopathy:

1. Points scored in their matriculation final examination

In South Africa all matriculants take subjects either on higher or standard grade and are allocated a symbol for each subject written, for example A = 80%, B = 70%, C = 60%, etc. According to their performance and the relative number of subjects offered on higher grade, they are granted university exemption or not. Traditionally, it is accepted that the level of assessment at standard grade is about 20% lower than that of the higher grade examinations in the same subject. The total points scored by a matriculant are then calculated according to a number of points allocated to the two grades according to the following scale:

HIGHER GRADE	STANDARD GRADE
A - 8	A - 5
B - 7	B - 4
C - 6	C - 3
D - 5	D - 2
E - 4	E - 1
F - 1	F - 0
G - 0	

University exemption, however, only implies minimal standards for acceptance and not automatic selection. Most South African universities require at least three subjects on higher grade and a total of at least 28 points scored on the above scale over six matriculation subjects. Individual disciplines frequently establish a higher cut-off point, for example the University of Natal Commerce Faculty

requires a minimum of 34 points. Available spaces are then filled in rank order by applicants who have at least the minimum requirements.

This same grading system is also applied in the selection processes into both the chiropractic and homoeopathy programmes. In actual fact, an academic “threshold” is determined and only students above that threshold are considered for possible selection.

In addition to the emphasis on academic achievement at school, two procedures are applied:

2. In order to gauge interest in and knowledge of the profession that they propose to enter, applicants have to research all available information about their planned career, as well as make contact with practitioners in the field and then produce an essay on why they want to study for that particular profession.
3. All students who meet the minimum academic “threshold” are then interviewed by a panel including present students as well as practitioners from the relevant profession.

Points 2 and 3 above together then form the basis for the final selection. In this selection process no criterion referencing takes place and strong emphasis is placed on point 1 above, in other words a normative judgement. Students are ranked according to prior academic performance on the more or less one-dimensional basis of “best” academic points score, with total disregard for their having achieved adequate academic maturity. Final decisions are made in the admissions interview, which is unstructured and has a strong subjective flavour.

Of specific concern is the high attrition rate in particularly the first three years of these two six-year programmes. Over the first ten years of these programmes, on average only 66% of chiropractic students and 55% of homoeopathy students successfully completed

the first year (Table 2). Over the same period of time, a staggering average of 23% chiropractic students and 27% homoeopathy students were “lost” to the programmes by the end of the first year (Table 3). The term “lost” students includes all academic exclusions as well as the voluntary withdrawals. The voluntary withdrawal group includes all those students who leave of their own free will and will, inevitably, include many academic failures as well. This group, however, also includes those students who leave for other reasons such as financial, personal, and health reasons.

The rules for the programmes in chiropractic and homoeopathy indicate very clearly when academic dismissal will take place (See Section 4.3.2). For example any first-year student who fails three or more subjects will not be allowed to re-register, or any student who fails a major subject twice at subsequent examination sessions (not including supplementary examinations that are seen as part of the main examination session) will also have to de-register from the course. A very thin line separates drop-backs (students who fall behind their group and graduate at a later stage) from academic dismissals. For example, a first-year student who fails one or two subjects is allowed to continue as a “hybrid” with a mix of subjects from two different years. There are, however, many rules dealing with pre-requisite and co-requisite subjects that will limit the number of subjects that a drop-back student may register for. With the exception of a very few minor subjects, such as physics, which may be “added on” to a full year, the failure of even just one subject inevitably adds a year or more to the student’s academic life. Drop-backs are therefore also very expensive from an institutional viewpoint.

Because of the extent of the problem as well as the serious financial implications of attrition, efforts to try and improve student retention should be very high on the institutional priority list. If the student at risk of academic failure could be identified early enough, there should still be enough time to provide remedial support programmes. Managers at tertiary institutions should know which support programmes will be required and for how many students it will be required. This information is essential to institutional management in order to calculate the financial implications of enrolling a student in each of the programmes at the institution. It must also be understood that the

planned dramatic transformation of the student demographic profile will lead to the entrance of more disadvantaged students and therefore the final cost of student support will need to be extrapolated in order to become part of the institutional financial and strategic planning (Gourley 1992). It cannot be left to academic departments that are often understaffed to carry the extra burden of supporting underprepared students. However, only once objective information exists about the extent of the problem of attrition as well as the type(s) of support that will be needed, can managers at the tertiary institution do the necessary planning.

1.2 STATEMENT OF THE PROBLEM

The problem investigated in this study was student attrition from institutions of higher education in order to identify those students potentially at risk of failure as early as possible.

1.3 SPECIFIC RESEARCH OBJECTIVES

As research results on attrition might only be valid for a particular sample of students, or for a specific programme of study, results are not necessarily generalizable from one institution to another. Educational management principles therefore dictate that the unique factors relating to discontinuation within its own province should be identified and described for every programme in a tertiary institution. This study therefore focused on the programmes chiropractic and homoeopathy at Technikon Natal. In order to provide a model that would assist institutions to retain as many students as possible, the problem of attrition was researched and quantified by answering the following questions:

- * How serious is the problem of attrition?
- * Who is the student at risk?
- * When is the risk of attrition the highest?

The high attrition rates that appear to exist around the world could be an indication that present selection strategies are not effective in eliminating potentially “at risk” students from tertiary studies. Taking cognisance of the very large number of student characteristics that have to be taken into account when making selection decisions, a conclusion could be reached that selection of the “correct” cohort of freshmen might be a very difficult task. Selection procedures are further compounded by the necessity to select students with specific characteristics for careers in the health field as well as by the fact that access to tertiary studies must be provided to large numbers of previously disadvantaged students.

Seen against some of these difficulties that face selection committees, it might well transpire that it is not possible to use admission strategies to meaningfully reduce attrition rates and that the major institutional focus will have to be on the period after the student arrives on campus. This possibility guided the author to concentrate the present research on the post-registration period.

Most tertiary institutions are providing student support programmes to disadvantaged students and it has been shown that such programmes do have value in reducing attrition and improving academic performance. However, in order to identify the students who would require such support services in order to be successful, objective methods should be developed whereby the earliest signs of academic difficulty after the start of the first year could be recognised. It was therefore decided to focus this study on the first year of study in the selected programmes, investigating results between 1989 and 1997.

Research in this field is essential, because if tertiary institutions are to reduce the rate of student attrition by changing their teaching, guidance, and support facilities, they must be guided by appropriate data. The existence of strong sensitivity in South Africa towards

any distinction made on the basis of race is another important reason for the development of objective models of predicting the student at risk as some students might interpret compulsory participation in support programmes as discriminatory practice.

In actual fact, support programmes must be available to all students who need it and who must be identified early enough for support programmes to positively affect their academic performance. Therefore, in order to identify as early as possible the at-risk students, freshman first and second test results, as possible predictors of students in need of support, were researched and quantified by answering the following questions:

- * Is there a relationship between marks scored in the first test series of the freshman year and success and/or failure at the end of the year?
- * Is there a relationship between marks scored in the second test series of the freshman year and success and/or failure at the end of the year?
- * Can a predictive model be developed from the first test results for the early identification of the freshmen who would require support in order to be successful at the end of the first year?
- * Can a predictive model be developed from the second test results for the early identification of the freshmen who would require support in order to be successful at the end of the first year?

1.4 CLARIFICATION OF TERMS

1.4.1. ATTRITION

Due to the increased pressure on institutions to be accountable and financially efficient, the need to understand (and to minimize) the phenomenon of attrition becomes more urgent every day. In order to effectively research this problem, it is extremely important for researchers to have a clear definition of attrition and also to reach a consensus about, or at least to state very clearly, the manner in which they define their critical groups. The way in which these terms are defined may affect the research findings and affect the study's usefulness to other researchers and educators.

The Oxford Dictionary defines attrition as 'the act or process of gradually wearing out, especially by friction' and equates it also with 'wastage' (Thompson 1995).

Spady (1970) states that two operational definitions of the college dropout are generally accepted and a review of the literature on the topic of student attrition since 1970 tends to support this conclusion. The first definition includes all students who leave (drop out of) an institution before completion of their chosen qualification. Whatever their reasons for leaving, this attrition rate thus indicates that percentage of a cohort of students who are lost to a particular programme at a particular institution. Most published studies fall in this category and define (or just imply) attrition to be the cessation of individual student membership in an institution of higher education. The perspective of such a definition is that of a single organization, and student attrition (or dropout, or discontinuation, or non-completion, or wastage) is associated with membership in a particular institution, rather than membership in institutions of higher education in general. The second definition of a dropout refers to those students who never receive a qualification from any tertiary institution. In a broader national context, student attrition is not necessarily synonymous with wastage, as many students who do not complete their studies at one institution might (eventually) do so at another.

The assumptions and research approaches appropriate to each of these two definitions are distinct and the definitions are important to different types of researchers. For those who are interested in a wider national perspective, the second definition would be of much more importance as it includes students who receive a qualification from another tertiary institution. For example, as early as 1978, Pantages and Creedon (1978) calculated that only four out of every ten students who entered college in the USA would graduate from that college four years later. One of the remaining six would eventually graduate from that college at some point later than those four years. Of the five students who dropped out of the college altogether, four would re-enroll at a different college and of these four, only two would eventually graduate. Of the six students who dropped out, three would do so during the first year. Two more would drop out during the second year, and the last one would drop out at some point after the second year. Three out of every ten students who originally entered college would never obtain a college degree. In the USA in 1978 this meant that, of the number of students that enrolled per year, in excess of two and a half million would completely drop out of higher education (Pantages & Creedon 1978). If these figures are extrapolated to the present time and were to include first-year students in the rest of the world, the sheer magnitude of the problem demands investigation.

Although the former and more traditional of the above two definitions is much narrower than the second, it is geared specifically to the concerns and policies of specific institutions as it regards any student who leaves the institution as a dropout. These students are important to a department/ institution because even though one accepts the fact that voluntary withdrawals, or even academic exclusions, might at some later stage qualify at another institution, or even at another department in the same institution, they still constitute a waste of resources in their original course of studies.

From the institutional point of view, attrition has a heavy impact on institutional operations and finance. Student attrition is a serious problem that affects the institution as far as pass rates are concerned. It therefore not only leads to decreased State funding and resultant inefficiency of the institution in cost-benefit terms, but every unsuccessful student theoretically also keeps a potentially successful student out of tertiary education.

The institution also has to deal with ethical considerations in respect of the futures of individuals who discontinue. From the student's point of view, the effect of dropping out, although difficult to gauge, is also another important aspect of the attrition problem and might mean not only a financial loss, but could be psychologically very traumatic to the student as well as to his/her family.

The attrition rate is thus of importance to departmental/ institutional planners, admissions officers, guidance and counseling personnel, for institutional strategic planning and commitment, and with the prediction, explanation, or prevention of student turnover. Because institutional registration information is updated on a regular basis and usually available on relatively short notice, this definition is methodologically much easier to handle and more reliable than the second (broader) definition.

In order to provide some guidelines towards the standardization of definitions, the Liaison Committee on Medical Education (LCME) in the United States categorizes attrition in the following manner:

1. dismissed/academic failure
2. withdrew in poor academic standing
3. withdrew/dismissed for all other reasons
4. transferred to another school

The LCME further categorizes student academic difficulty as:

1. required to repeat entire year
2. required to repeat one or more courses but less than a whole year
3. required to take remedial course work (Cariaga-Lo *et al.* 1997).

From a tertiary institutional viewpoint, all students who either discontinue their studies prematurely, or fall behind their peers by one or more years, must be seen as very important. In South Africa State funding is directly linked to student success and every student who does not complete a programme on time, or does not complete at all, affects

the economic viability of the institution. In order to do effective financial planning, managers at tertiary institutions are reliant on correct information regarding the problem of attrition as well as the numbers of students that would require support mechanisms in order to successfully pass their studies. To be able to quantify and standardize the problem of attrition across programmes in an institution as well as across institutions, the following categorizations were used in this study:

1. SUCCESSFUL	Students who pass all subjects at one examination period (final examination plus supplementary examination sessions) and are thus on target to complete the programme in the minimum time period.
2. DROPPACKS	Students who become “hybrids” in that they carry over some subject/s and therefore fall one or more years behind their peers.
3. ACADEMIC EXCLUSIONS	Students who fail three or more subjects in the first year or fail a major subject twice and are then not allowed to re-register for the programme
4. VOLUNTARY WITHDRAWALS	Students who leave of their own accord before completion of the programme

This categorization discriminates successfully between the different forms of leaving behaviour that are important to educational managers.

1.4.2 OTHER TERMS USED

- * **STUDENTS LOST TO THE SYSTEM**
All students who become academic exclusions plus the voluntary withdrawals that leave the institution without completing the programme.
- * **STUDENTS AT RISK**
All students who are potential drop-backs and academic exclusions and who are thus in danger of failing the year.
- * **STUDENTS WHO REQUIRE SUPPORT**
Same as students “at risk”, i.e. all students who are potential drop-backs and who are thus in danger of failing the year unless they are provided with remedial/ support measures.
- * **FRESHMAN**
First-year student.
- * **FIRST-TIME FRESHMAN**
A young school leaver who has had no break between completing school and entrance into the freshman year.
- * **OLDER FRESHMAN**
All students who are older than 18 years and have had obvious breaks between completing school and entrance into the freshman year are classified as “older” regardless of how the intervening years were spent.

1.5 AN OVERVIEW OF THESIS LAYOUT

1.5.1 CHAPTER ONE

An overview is provided on the problem of student attrition from tertiary institutions as seen against the present socio-economic climate in South Africa. Cognisance is taken of the fact that access to tertiary studies must be provided to previously disadvantaged students and that the majority of future students in South African tertiary institutions should be representative of these groups. This influx of underprepared students will further aggravate the problem of attrition. The already serious financial problems experienced by tertiary institutions are escalated by increased attrition rates and compounded by a decrease in state funding per student. Cost per student must be carefully considered by tertiary institutions and should tertiary institutions embrace their social obligation by a decision to change their student demographic profile, they must do so on the basis of an enlightened understanding of the increased cost of this undertaking. At risk students cannot be left to fail and tertiary institutions will have to accept their responsibilities to all students that they allow to enroll.

Tertiary institutions cannot afford the high student losses and must find ways by which the problem can be managed and the problem of student attrition minimized. In order to do so it is firstly necessary to quantify the problem of student attrition per programme per institution and then to develop methods to manage the problem.

In the present study student attrition from Technikon Natal was thus considered and the two six-year programmes chiropractic and homoeopathy were used as examples. It was posited that substantial reductions in attrition rates would only be possible in the post-registration phase. It was thus proposed to first determine whether and at which stage of these two programmes a problem of attrition existed and then to use test results obtained in the first and second test series of the first year to develop prediction models for the early identification of those freshmen in need of support.

1.5.2 CHAPTER TWO

Three theoretical models of attrition (Spady 1970; Tinto 1975; Tinto 1997; Johnson & Buck 1995) are discussed in detail. It became clear that attrition was a highly complex problem dependent on many student characteristics and aspirations that a student brings to a tertiary institution, as well as on the interaction, once the student has been enrolled, of these characteristics with the institution. From these models the author drew the conclusion that two phases in attrition could be identified in any attempt to manage the problem and increase retention. The first phase would be in the pre-registration period where the institution selects students into a programme on the basis of their personal characteristics. The second phase would be after the student arrives on campus and interaction takes place between the student's characteristics and institutional characteristics which together will determine the student's academic integration and commitment to graduation.

In this chapter the author suggests that the variety and complexity of the pre-registration characteristics might preclude their use for the development of a prediction model which would explain the major part of the variation in the student's academic performance at the tertiary institution. It is thus suggested that institutional efforts at substantially reducing attrition rates might have to be focused on the post-registration period. If an individual student's academic integration could only be measured after the start of tertiary studies, then the first assessments of the freshman year (the first and second test series) might be useful for identification of the freshmen who would need support in order to successfully complete the first year of studies.

1.5.3 CHAPTER THREE

An in-depth review of the literature indicated that student attrition from institutions of higher education was a problem of significant magnitude and of multifactorial causation and one which impacted negatively on the cost-efficient management of tertiary

institutions. The first year of studies has emerged as the most dangerous from a non-completion point of view and that students from disadvantaged academic backgrounds appeared to experience greater difficulties in adapting to the tertiary education system and to being successful in their tertiary studies.

Two interception phases were identified in the process of management of attrition, i.e. firstly from pre-registration data, and secondly from post-registration data. The literature indicated that attrition rates around the world remained high despite very elaborate selection methods and that a substantial part of the variation in students' academic performance appeared to be unpredictable from the evidence available at the time of registration. The large number of personal characteristics that students bring with them to the institution, together with the different experiences that the students undergo once they arrive on campus, might indicate that the problem is too complex to allow for substantial reduction of attrition in the pre-registration phase.

If all of the potentially at risk students cannot be identified and therefore eliminated before registration, then pre-registration data might, at best, be useful for screening purposes and institutions should focus on the post-registration period for any substantial reduction in attrition rates.

Research showed that support programmes had value in reducing attrition and improving academic performance. Although a strong feeling apparently existed that first test results, or any other early form of assessment in the first year of studies, were good indicators of later success, this area had not been well researched as yet. No study could be found that attempted to use academic performance in the first year of studies to develop an objective model for the early identification of the freshman that would require support in order to be successful at the end of the first year. This fact guided the author to concentrate the present research on the development of an early warning system for the identification of the student at risk of failing the first year of studies in chiropractic and homoeopathy at Technikon Natal.

1.5.4 CHAPTER FOUR

An ex post facto research design was used making use of the data obtained from the computerized record cards of all chiropractic and homoeopathy students registered at Technikon Natal between 1989 and 1997 inclusive. As predictor variables the test results obtained in the first and second test series of the freshmen year were used. The criterion variable was academic outcome at the end of each of the first three years of these two six-year programmes. Every student was categorized into successful, dropback, academic exclusion, or voluntary withdrawal according to performance over the first year of studies and as dictated by the departmental rules for each programme.

The research was divided into four different studies. In Study 1 a descriptive study was undertaken to quantify and describe the problem of attrition in the first three years of the two six-year programmes chiropractic and homoeopathy. In Study 2 results from the first test series were utilized firstly to investigate whether a relationship could be demonstrated between the test results and academic outcome at the end of the freshman year. Secondly, an estimated logistic regression was developed from the first test results in an attempt to use these results for the early identification of the student at risk. The logistic regression model, which was estimated from data between 1989 and 1995 inclusive, was then validated on the data of 1995 and 1996.

In Study 3 the same procedure as in Study 2 was followed, except that the predictor variables were test two results. In Study 4 the same data as in Studies 2 and 3 were used in discriminant analyses in order to investigate whether two different (and powerful) statistical procedures (i.e. logistic regression and discriminant analysis) could both indicate that early test results from the freshman year were useful predictors of academic outcome at the end of the year.

1.5.5 CHAPTER FIVE

In this chapter the data generated by means of the different techniques described in Chapter four are reported. In Study 1 the current reality existing in the chiropractic and homoeopathy programmes are reported. The problem of attrition is described for the first three years of study by means of tables and graphs. The data covered the period between 1989 and 1999 inclusive. Of special importance in this regard were the percentage successful students, as well as percentages of students that were not successful, i.e. dropbacks, academic exclusions and voluntary withdrawals.

In Study 2 the data indicating an apparent relationship between first test results and academic outcome at the end of the freshmen year are shown. This reporting is done by means of tables and graphs. Subsequent to the demonstration of this relationship, the logistic regression model estimated from test one is reported and interpreted. The diagnostic procedures confirming that the estimated logistic regression model fits the data quite well are also displayed. The logistic regression model estimated retrospectively from the 1989 to 1995 data was validated on the 1996 and 1997 data. The sensitivity, specificity, as well as Type I and Type II errors of the model are indicated. In Study 3 the data reporting is exactly the same as in Study 2, except that second test results were used as the predictor variables, and reported.

In Study 4 discriminant analysis models using firstly Test 1 and then Test 2 results as predictor variables are reported. In both cases the sensitivity and specificity of the models are indicated both for the original classification method as well as with the cross-validated classification method. Diagnostic measures confirming that the developed logistic regression models fit the data quite well are reported for both models.

1.5.6 CHAPTER SIX

In this chapter the data reported in the previous chapter are discussed and compared with published results from other researchers. The descriptive study indicated very clearly that the numbers of students “lost” from both the chiropractic and homoeopathy programmes were unacceptably high and that the first year of study was the most dangerous from a non-completion aspect. On average only 66% of chiropractic and 55% of homoeopathy freshmen were successful at the end of the year and the success rate dropped to only 46% and 39% respectively by the end of the third year.

A relationship was demonstrated between both first and second test results and outcome at the end of the first year of studies. A logistic regression model estimated retrospectively from first test results in physiology, anatomy, biology and chemistry was able to discriminate between successful and non-successful freshmen with an overall predictive accuracy of 80.82%. When this model was validated on a different set of data it was shown to have a very high sensitivity and was thus able to correctly identify >93% of the potentially “at risk” freshmen. It also had a low Type II error (<7%) and thus missed very few of the freshmen at risk of failing at the end of the year.

A logistic regression model estimated retrospectively from second test results in physiology, anatomy, biology and chemistry was also able to discriminate between successful and non-successful freshmen with an overall predictive accuracy of 85.94%. When this model was validated on a different set of data it was shown that the sensitivity of the model was too low (67%) for the model to be of much use as a management tool for the identification of the freshmen at risk of failing (or in need of support). However, the model was shown to have a very high specificity and was able to correctly identify >93% of the potentially successful freshmen. It also had a low Type I error (14.29%). This means that only approximately 14% of the freshmen who were actually successful at the end of the first year was predicted as being not successful.

Discriminant analysis models estimated from both first and second test results in physiology, anatomy, biology and chemistry were also able to discriminate well between freshmen who would be successful and freshmen who would need support in order to be successful. The results from the discriminant analyses thus also produced strong support for the use of test results for the early identification of those freshmen who would need support in order to be successful.

1.5.7 CHAPTER SEVEN

In this chapter recommendations are made for research that is urgently required to further investigate the problem of attrition in the chiropractic and homoeopathy programmes at Technikon Natal.

It is suggested that the objective models developed in this research could be of great importance in the institutional management of the problem of attrition as they provide the ability to identify the freshman in need of support at an early enough stage for support measures to be implemented and still to be effective in reducing attrition rates.

CHAPTER TWO

THEORETICAL BACKGROUND

STUDENT ATTRITION FROM TERTIARY INSTITUTIONS

The academic success and retention of students are of primary importance to academic managers, especially so in an era of declining resources. The problem of attrition is widespread with almost all higher education institutions having a significant proportion of students who discontinue their studies. Especially in the early years of study, rates of discontinuation tend to be particularly high. Attempts by policy makers, administrators, and teachers to reduce these rates by means of improved selection procedures, the provision of better guidance and counseling services, and by the improvement of teaching and learning, appeared to have had little or no effect.

A vast body of research covers the topic of student loss or discontinuation from institutions of higher education, but still the available knowledge about this process is surprisingly limited. Twenty four years ago Tinto (1975) stated that the fact that past research had failed to delineate the 'multiple characteristics of dropout' more clearly, could be attributed to two main shortcomings. The first of these was the inability of researchers to define clearly what they meant by dropouts, and the second was the failure to develop theoretical models that attempted to explain, and not only to describe, the processes that caused individuals to drop out of institutions of higher education. Munro (1981) added that the lack of control groups was another possible shortcoming in such research on attrition.

2.1 DETERMINANTS OF STUDENT ATTRITION

Not all student attrition is bad. There may be very legitimate reasons for a student to leave an institution of higher education. Unfortunately many of the published studies on the topic of attrition have investigated correlations between dropout and selected student or institutional characteristics, without distinguishing clearly (or at all) between academic difficulty and voluntary withdrawal as reasons for non-completion.

It does appear from the available literature as though academic difficulty is the most important reason for attrition. Simpson and Budd (1996) report that the majority of students (53%) who left the medical school at Leeds University in the United Kingdom before completion of their studies were asked to withdraw for academic reasons. Various reasons were listed for the voluntary withdrawal of the remaining 47% of leavers, of which the most common appeared to be personal reasons. A number of other authors also indicated that academic problems put students at risk of non-completion (e.g. Bean 1980; Bean & Metzner 1985; Johnes & Taylor 1989; Johnson & Buck 1995; Huff & Fang 1999). Spady (1970:64) indicated that it was necessary to acknowledge the *'inseparable relationship'* between college dropouts and academic performance.

It must be remembered though that poor academic performance is not the only reason for student non-completion. Many students who have good grades also leave the course of study that they embarked on. A national study was undertaken by Yorke (1998) to investigate the non-completion of full-time and sandwich students in English higher education for the academic year 1994-1995. An analysis of 1 478 responses to the survey of non-completers in six institutions in north-west England suggested that there were eight main factors involved, each of which could be related to one or more levels of the educational system. These were:

- * Wrong choice of field of study
- * Inability to cope with the demand of the programme
- * Unsatisfactory experience of the programme

- * Dissatisfaction with institutional provision of facilities
- * Problems associated with finance
- * Unhappiness with the locality of the institution
- * Health-related problems
- * Problems associated with relationships.

Some of these factors, such as problems relating to health, relationships, and institutional locality, relate very strongly to the student and little - if at all - to the institution or system levels. Other factors listed above are, however, not so easy to categorize and could be attributed to both the student and to the institution. For example, the wrong choice of field of study (described as moderately or considerably influential on withdrawal by 40% of respondents) might to the greatest extent be attributed to the student, but both the educational system and the institution might also be significant contributors to this problem.

The majority of published studies investigating student attrition have been correlational studies at single institutions, often using follow-up surveys to attempt to establish why students left an institution. Pascarella and Terenzini (1983) criticized early research on this topic as being mostly descriptive and emphasizing the statistically significant correlates of persistence/withdrawal behaviour, without giving much attention to understanding the underlying dynamics of the phenomenon. However, beginning with the work of Spady (1970, 1971) and Tinto (1975), theoretical models have been advanced in an attempt to explain the variations in student attrition. Both these models of attrition were based in part on Durkheim's theory of suicide with the link between dropping out of school and suicide suggested as a theoretical basis for those models (Bean 1980).

2.1.1 SPADY'S EXPLANATORY SOCIOLOGICAL MODEL FOR THE DROP-OUT PROCESS

Spady (1970) examined the dropout process from higher education from a number of different operational definitions and intellectual perspectives. Although he developed the first theoretical model of attrition, he makes it quite clear that it would not be possible for a single theoretical model or research design to systematize or operationalize the specific relationships among the large number of variables that have been implicated in dropout behaviour.

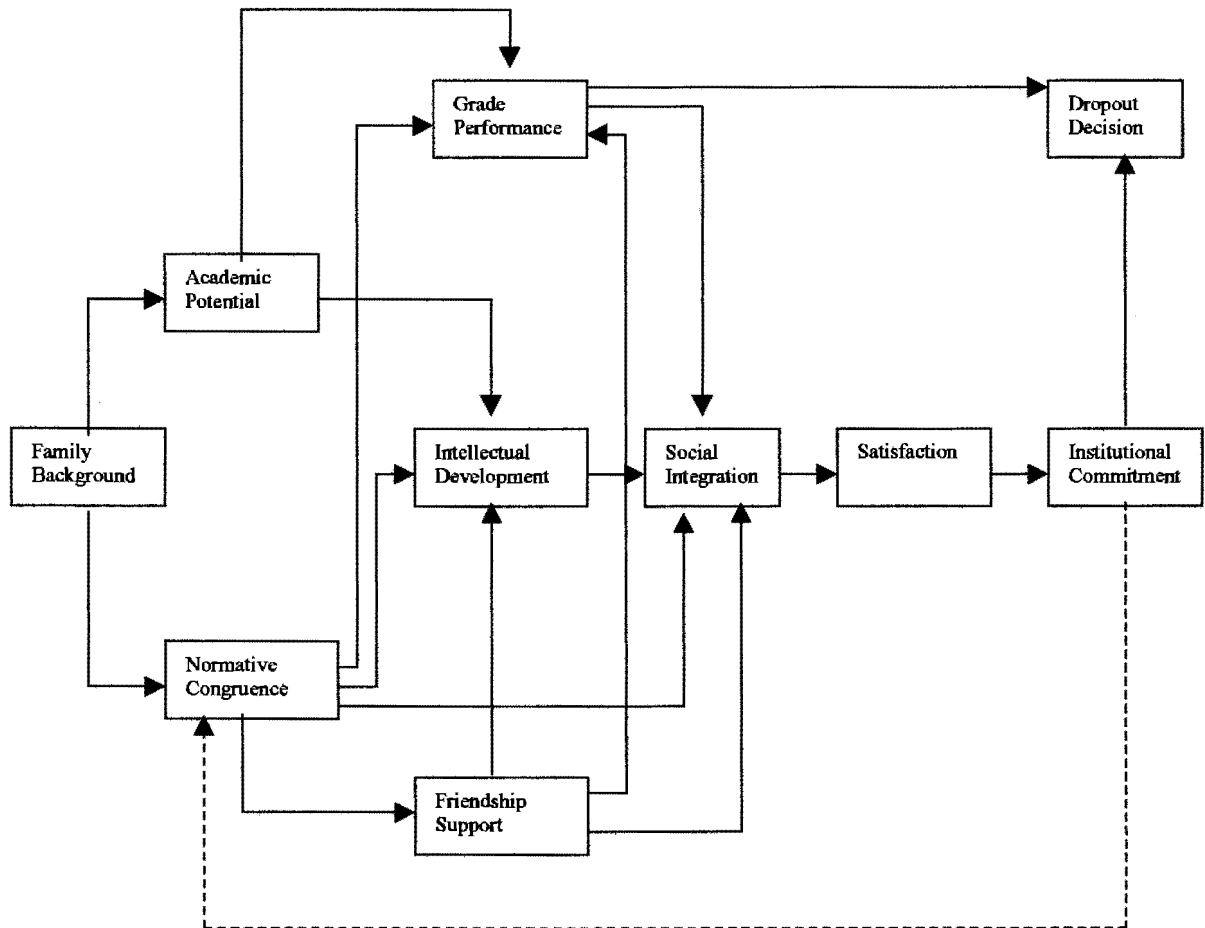
As a starting point to the development of his sociological model for the dropout process, Spady (1970) postulated that the dropout process would be best explained by an interdisciplinary approach involving an interaction between an individual student and the tertiary environment. In this interaction the attributes of the student (i.e. dispositions, interests, attitudes, and skills) are exposed to influences, expectations, and demands from a number of different sources such as the courses taken, academic staff members, administrators, and peers. Through this interaction, the student is provided with the opportunity of assimilating successfully into both the academic and the social systems of the institution. Both these systems are regarded as important frameworks from which the dropout process must be examined.

Available within both the academic and the social systems of the tertiary institution there are certain rewards. Spady (1970) suggested that if rewards from either of these two systems appear insufficient, the student might decide to withdraw. Within the academic system, these rewards could be extrinsic (grades) or intrinsic (intellectual development). Within the social system, "success" would depend on the student having attitudes, interests, and personality dispositions that are compatible with the attributes and influences of the environment (normative congruence). Together with this would also be required an ability to establish close relationships with others in the system (friendship support).

The elementary Durkheimian model proposed by Spady (1970) (Figure 1) consists of five independent variables. Four of these variables, namely grade performance, intellectual development, normative congruence, and friendship support influence the fifth, i.e. social integration. The link between social integration and dropping out was seen to be indirect with at least two critical variables flowing from the integration intervening in this process. The addition of these two critical variables, namely satisfaction with tertiary institutional experience, and commitment to the social system, was based on two assumptions. It was firstly assumed that satisfaction with institutional experience would depend on the available social as well as academic rewards, and secondly that a sense of integration into the system as well as a number of positive rewards would be necessary to sustain the commitment to the institution.

FIGURE 1

**SPADY'S EXPLANATORY SOCIOLOGICAL MODEL FOR THE DROPOUT
PROCESS (Spady 1970:79)**



This model implies a definite time sequence and also depicts the assumed direct causal connections between pairs of variables. The broken arrow leading from institutional commitment back to normative congruence must be seen as important as it implies that the model is cyclical and flexible. Spady (1970) thus suggests that the result of the process might also lead to changes in the student as far as attitudes, interests, goals, or motivation are concerned. Such changes might, in turn, affect later stages of the student's tertiary career.

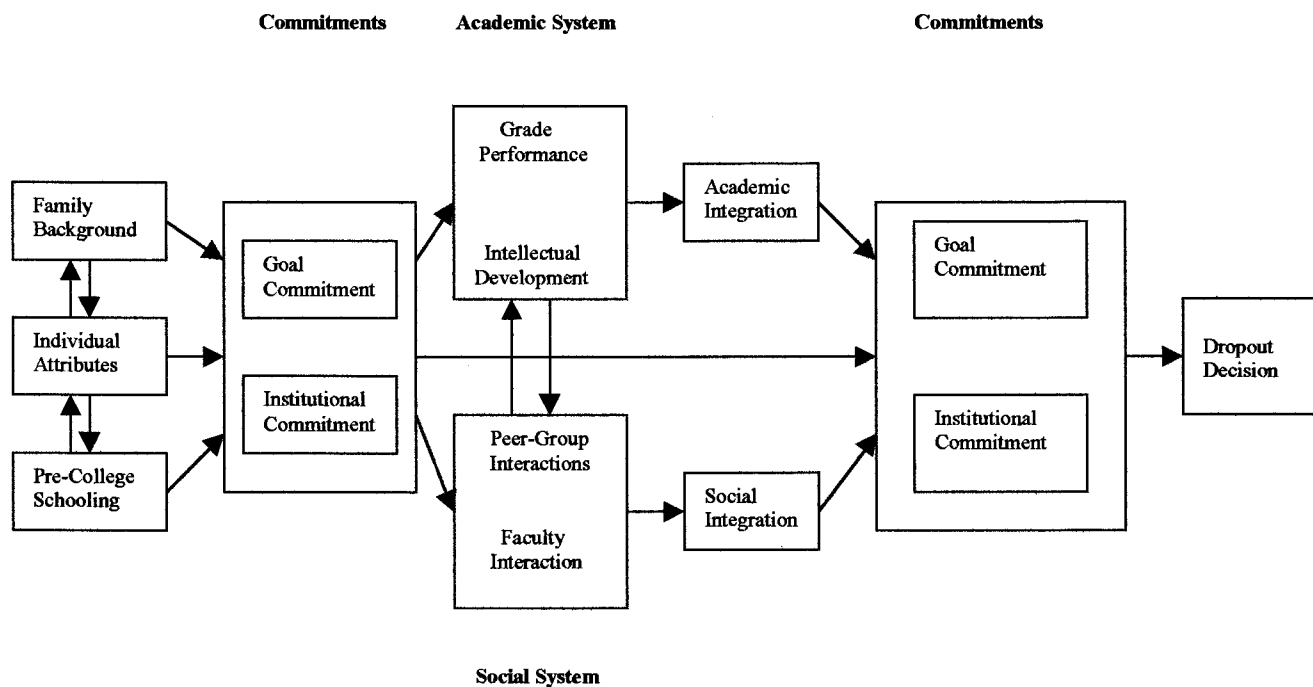
2.1.2 TINTO'S CONCEPTUAL SCHEMA FOR DROPOUT FROM COLLEGE

Building on and extending Spady's (1970) earlier work, Tinto (1975) developed an explanatory, theoretical model of the persistence/withdrawal process in postsecondary institutions (Figure 2a).

FIGURE 2a

TINTO'S CONCEPTUAL SCHEMA FOR DROPOUT FROM COLLEGE

(Tinto 1975:94).



In brief, Tinto's model (Figure 2a) views the academic and social integration of an individual student into a tertiary institution and the student's interaction with these systems as the primary determinants of persistence. Attrition is seen as a longitudinal process involving a complex series of sociopsychological interactions between the

student and the institutional environment. According to the theory behind the model, each student brings to tertiary education his/her own set of characteristics such as family background (e.g. socio-economic status, or parental values), as well as personal attributes (e.g. gender, race, academic ability, and personal traits), and also experiences (e.g. precollege social and academic achievements). These lead to initial commitments, both to the institution attended and to the goal of graduation from college. Together with such background traits, these initial commitments influence not only how well the student will perform academically, but also how he/she will interact with and subsequently become integrated into the institution's social and academic systems. Other things being equal, the greater the individual's level of social and academic integration, the greater the subsequent commitment to the institution and commitment to the goal of graduation, respectively. In turn, these commitments are seen, along with levels of integration, as having a direct, positive influence on persistence (Tinto 1975).

Tinto's model is an important contribution to the understanding of the attrition problem, rather than simply an algorithm for predicting it, since it portrays in some detail the longitudinal process of student-institutional fit leading to persistence/withdrawal behaviour. It is also important to note the suggestion by Tinto that potentially important compensatory interactions among constructs can occur. Tinto hypothesized, for example, that in terms of influence on persistence, a high level of commitment to the goal of graduation may tend to compensate for a low level of commitment to the institution, and vice versa. Similarly, one might logically extend Tinto's reasoning and hypothesize that a high level of overall academic integration would tend to compensate for a low level of social integration.

Both Spady's (1970, 1971) and Tinto's (1975) theoretical models were welcomed with high acclaim by educational researchers. Bean (1980), however, expressed some serious criticism of both these models, mainly because he felt that the definition of variables used in the analysis rendered the models unsuitable for path analysis. He felt that strict attention was not paid to the recursiveness (directional causality) of the variables in the theoretical models, or to the discreteness of the variables. As an example, he mentioned

Spady's (1971) definition of 'normative congruence' as containing 5 major clusters of variables, including a student's high school contacts, his personality dispositions, moral values and attitudes towards the target population, as well as measures of campus subcultural orientations. The same criticism held for the Tinto (1975) model.

Tinto (1997) reported on research undertaken in a further attempt to work towards an understanding of the educational character of persistence in higher education. The author believed that the classroom should be viewed as the centre of the educational activity structure of institutions of higher education. It was suggested that the majority of educational encounters took place within the classroom and that the classroom was thus the most likely place for academic and social involvement or integration to take place.

To test this hypothesis an investigation was undertaken to determine whether an alteration of the student classroom experience through the use of learning communities and the adoption of collaborative learning strategies could enhance student learning and persistence.

The author compared freshmen involved in a Coordinated Studies Programme (CSP) with freshmen who were enrolled in traditional curricula. Students in the CSP had the opportunity to share the curriculum and share the experience of learning in several courses that were tied together by a unifying theme. The students participated in cooperative learning activities that called for them to be interdependent learners where the learning of the group depended on the learning of each member of the group.

The results of a longitudinal survey together with a qualitative case study indicated a significant difference between the two groups. Five variables proved to be significant predictors of persistence, namely participation in the CSP, college grade point average, hours studied per week, perceptions of faculty, and the factor score of involvement with other students. Being a member of the CSP thus proved to be an independent predictor of

success into the second year of college. This fact remained even after controlling for performance and other attributes and behaviours of the students.

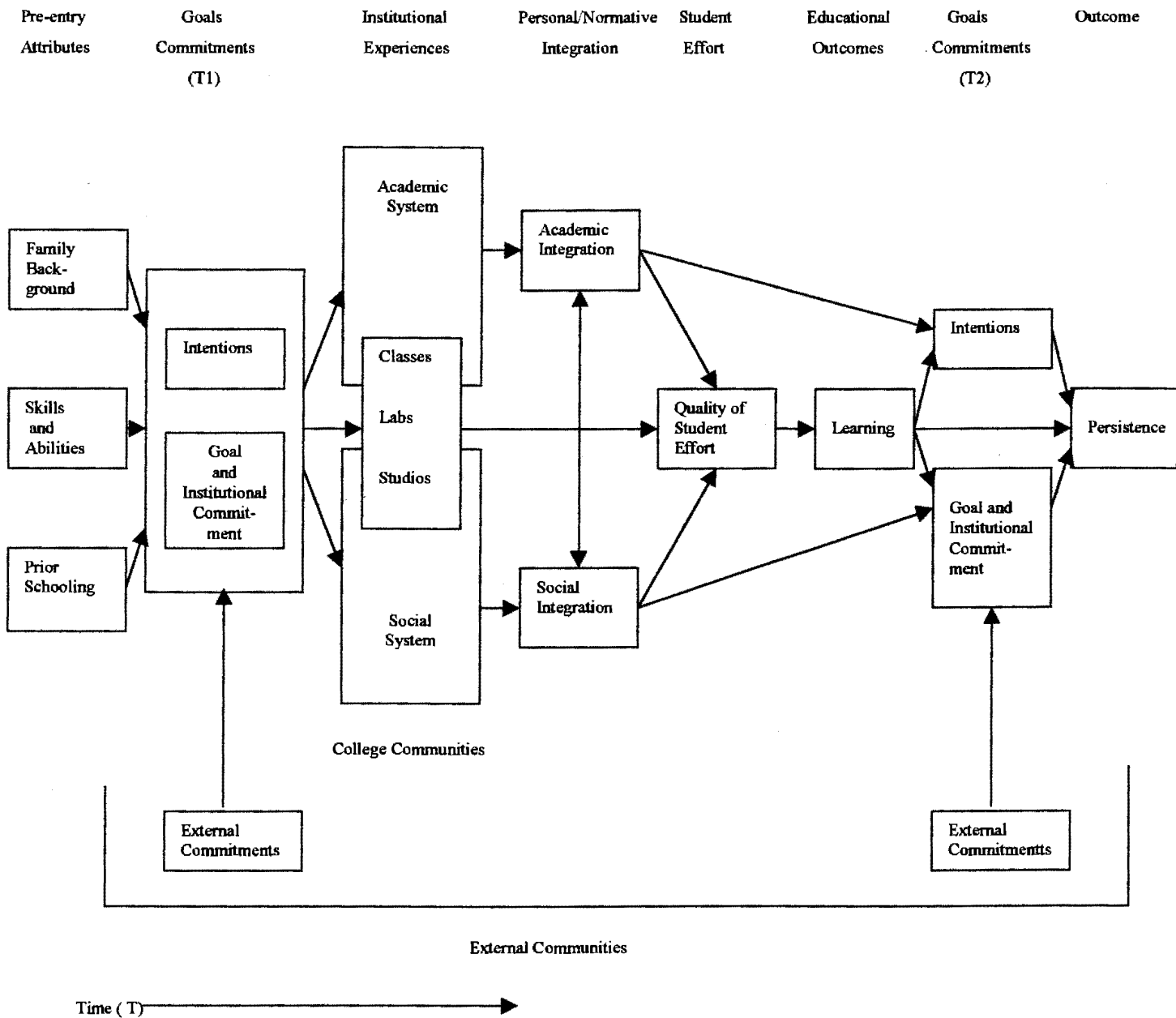
Tinto (1997) concluded that the results of the reported study provided insight into the ways in which classroom experience could shape student persistence and that the existing theories of student persistence should thus be modified to better reflect the educational character of college life. It appeared as though important relationships were indicated between the educational activity structure of the classroom, student involvement, and the quality of student effort on the one side and, on the other, between quality of student effort, learning, and persistence.

It was suggested that student social involvement in the educational life of the college provided a mechanism through which both academic and social involvement arose and student effort was engaged. The more students became involved, both academically and socially, in shared learning experiences that link them with their peers, the more likely they were to become involved in their own learning and therefore would invest more time and energy into learning. It was felt that the social affiliations provided by such activities would serve as a vehicle through which academic involvement was engaged. Students tended to put more effort into that form of educational activity that enabled them to bridge the academic-social divide in order for them to make friends and learn at the same time. Such increased learning, it was suggested, then resulted in enhanced learning in ways that would increase persistence.

A modified theory of student persistence, which linked classrooms to effort and persistence was then proposed (Figure 2b).

FIGURE 2b

TINTO'S MODIFIED MODEL LINKING CLASSROOMS, LEARNING, AND PERSISTENCE (Tinto 1997:615)



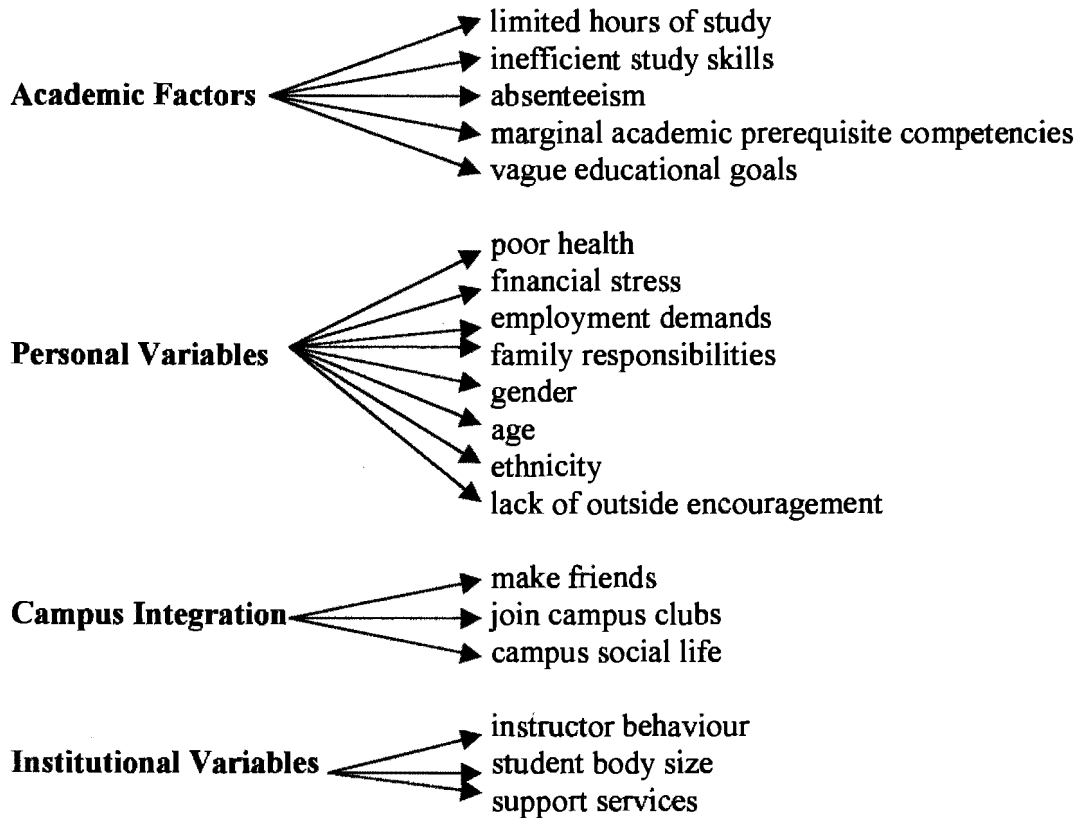
The main difference between this model and the previous one by Tinto (Figure 2a) is the fact that the social and academic systems are not depicted as two separate boxes but as nested spheres where the academic system occurs within the broader social system. The updated model thus only attempts to incorporate the effect that interactions in the classroom could have on student withdrawal or persistence. It in no way alters the understanding that students enter into a tertiary institution with their own individual sets of characteristics and that those characteristics interact with the institutional characteristics leading to individual commitments, both to the institution attended and to the goal of graduation. It just suggests that the social and academic life was interwoven and that social communities emerge out of academic activities that take place within the more limited academic sphere of the classroom, a sphere of activities that is necessarily also social in character.

2.1.3 JOHNSON AND BUCK'S CONCEPTUAL MODEL OF UNDERGRADUATE STUDENT ATTRITION

Johnson and Buck (1995) also criticized former models of attrition from tertiary institutions because none of these models actually differentiated between institutional and personal withdrawal decisions. They felt that these models tended to focus on specific aspects of university attrition and were thus 'deficient in comprehensive application'. In an initial attempt to address the issue of Canadian University attrition, these authors compiled a list of characteristics relating to student attrition (Figure 3) from a comprehensive review of studies on student attrition. A wide range of student characteristics has been implicated in undergraduate withdrawal.

FIGURE 3

CATEGORIES AND EXAMPLES OF CHARACTERISTICS ASSOCIATED WITH UNDERGRADUATE STUDENT WITHDRAWAL (Johnson & Buck 1995:56).



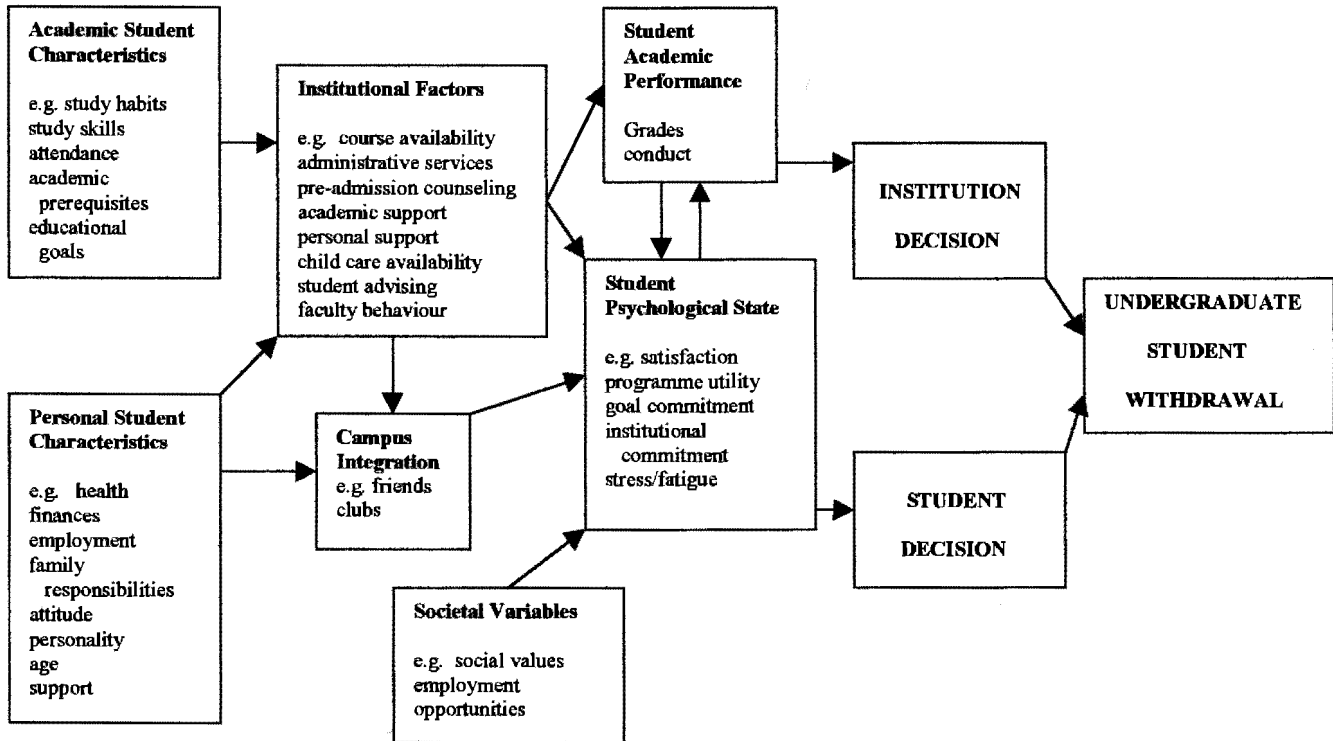
A scrutiny of this list, as well as of the plethora of studies on the topic of attrition, makes it quite clear that attrition is a very complex phenomenon and that it is essential to distinguish very clearly between different types of attrition. Care must be taken not to portray all students who withdraw from tertiary studies as having a particular personality profile or as lacking important attributes that are essential to academic success in tertiary studies. Not all students who discontinue their studies can be labeled as failures. In this regard, Tinto (1987:3) stated, *'the label dropout is one of the more frequently misused terms in our lexicon of educational descriptors'*. A clear distinction needs to be made

between students who voluntarily withdraw and those who are required to withdraw by their institutions.

As a further step in addressing the issue of Canadian University attrition, Johnson and Buck (1995) proposed a conceptual model of undergraduate student withdrawal (Figure 4). The bases of this model were findings obtained from questioning 498 out of the 2 247 students who had withdrawn from a large Western Canadian university during the 1991/1992 academic year. For reasons of confidentiality, the Registrar of the university provided only the names and addresses of the withdrawing students and the researchers had no indication of which students had withdrawn voluntarily or which had been required to withdraw by the institution. Once contacted, students were asked to specify the nature of their university withdrawal. Personal student characteristics, institutional factors and societal variables frequently emerged as students' reasons for withdrawing from university. The results of this study validated student academic performance as the causal factor for institutional-based undergraduate withdrawal and student psychological state appeared to be critically related to student-based undergraduate withdrawal.

FIGURE 4**A CONCEPTUAL MODEL OF UNDERGRADUATE STUDENT ATTRITION**

(Johnson & Buck 1995:58).



This model is comprehensive in scope and clearly distinguishes between student-initiated and institution-initiated university withdrawal. It is based on the assumption that a wide range of personal and academic variables characterizes students and that these characteristics interact or co-exist with institutional variables such as campus integration. This interaction results in the quality of the students' academic performance and the nature of the students' psychological condition. Poor quality of student academic performance results in institution-initiated undergraduate withdrawal, while a variety of

psychological variables (e.g. satisfaction and stress) results in student-initiated undergraduate withdrawal.

Whilst the institutional decision is usually based upon inadequate student academic performance, although misconduct such as plagiarism and cheating make necessary some withdrawals, personal withdrawal decisions are usually more complex. As indicated in Figure 4, students decide to withdraw from their undergraduate programmes on the basis of two main factors, namely academic performance and psychological state. During their studies, students generate a perception of the quality of their academic performance and they evaluate that perception against a personal standard as well as against the standard set by the institution. Aitken (1982) states that academic performance is assumed to directly affect withdrawal decisions not only because institutions set a minimum level of academic performance, which must be met in order for the student to remain in the institution, but also because the institutional measure of academic performance provides a direct message as to how well the student is doing relative to both the student's peers and an absolute standard. If success breeds success, then the opposite is also true. Once a student realizes that he/she is not coping, he/she may get despondent and do even worse. This result will also have an effect on the student's psychological state.

Each student is thus characterized by a psychological state that is influenced by many factors, amongst these campus integration and societal forces such as perceived employment options. Johnson and Buck (1995) explain that student academic performance and student psychological state at the most fundamental level are the result of an interaction between student academic/personal characteristics and institutional factors. In other words, each student is characterized by a unique combination of academic (e.g. study skills, academic prerequisites) and personal (e.g. health, family responsibilities) attributes. The unique combination of student characteristics for each and every student then interacts with the institutional variables such as course availability, staff behaviour, and support services. It is this interaction between the individual student and the institution that results in the student's academic performance

and psychological state, both of which form the bases for institutional and personal withdrawal decisions.

2.2 CONCLUSION

The theoretical models of attrition discussed above were attempts at identifying the variables and relationships which best explain attrition. It became clear from these models that attrition was a highly complex problem dependent on many student characteristics and aspirations that a student brings to a tertiary institution, as well as on the interaction, once the student has enrolled, of these characteristics with the institution. What also became apparent was the fact that student attrition was a longitudinal process and that any attempt to minimize this phenomenon must include the institution of strategies both before as well as after registration.

It appears from a scrutiny of the models of attrition that two phases should be identified in any attempt to manage the problem of attrition. Firstly, there are the characteristics that students bring to the tertiary institution (the pre-registration characteristics). Any selection strategy or model of prediction that could correctly identify from such pre-registration characteristics that cohort of first year students who would successfully complete their studies would be ideal and would dramatically reduce attrition rates. However, a scrutiny of the models of attrition indicates that a predictive model that could explain the major part of the variation in students' academic performance at a tertiary institution from evidence available at the time of registration might be extremely difficult (if not impossible) to develop. The variety and complexity of the pre-registration characteristics involved might preclude the development of such a model. Added to this difficulty must also be seen the fact that, particularly for medical-type studies, selection has to take place according to personal characteristics that will increase the likelihood of graduating caring and competent health workers. In South Africa large numbers of students from previously disadvantaged communities must also be allowed access into tertiary education. The perceived difficulties around the use of pre-registration

characteristics might therefore exclude the possibility that only successful students can be identified before registration. This possibility will be further investigated through a study of the available literature on the topic.

Secondly, it has also become apparent from a scrutiny of the models of attrition that an individual student's preregistration characteristics interact with institutional characteristics and that together they will determine the student's academic integration and commitment to graduation. It might thus be a fact that attrition reduction efforts would need to be focused on what happens to students after they have registered at a tertiary institution. If an individual student's academic integration could be measured at an early enough stage of the first year, then students who are academically at risk could be identified early enough for support mechanisms to be instituted and to still have a positive effect on student retention.

CHAPTER THREE

LITERATURE REVIEW

3.1 STUDENT ATTRITION FROM TERTIARY INSTITUTIONS

3.1.1 THE EXTENT OF STUDENT ATTRITION

As a start to this study which would attempt to reduce attrition rates by the early identification of students at risk of failure, it was first necessary to establish whether attrition was regarded as a problem serious enough to warrant time and other resources spent on it. A review of the available literature revealed that the problem of student attrition was widespread, and that the rate of student attrition in most institutions of higher education had remained high for more than 70 years and was still high at the time of this study. With the exception of a few national surveys, most of the published studies reviewed took the form of self-evaluative research by individual tertiary institutions.

3.1.1.1 STUDENT ATTRITION ABROAD

In the United States, Summerskill (1965) reviewed 35 different studies of student attrition published between 1913 and 1962. He found that colleges lost, on average, about half of their students in the four years after matriculation, and that only 40% of the college students graduated on schedule. In this report it was concluded that the attrition rate showed no appreciable change between 1920 and 1962.

A number of excellent, comprehensive literature reviews since that date such as those by Spady (1970), Tinto (1975) and Pantages and Creedon (1978) all reported the fact that

student attrition was a serious problem. Cambell and Dickson (1966) conducted a 10-year review using integrative review and meta-analysis of studies investigating student success in baccalaureate nursing programmes. They reported that 44% of all students who were admitted to baccalaureate nursing programmes failed to complete their programme successfully.

A number of more recent self-evaluative research studies by individual tertiary institutions in the United States reported serious attrition. From all reports it also appeared as though the problem of attrition was similar across all types of tertiary educational institutions. Anderson *et al.* (1985) for example found that 46% of all students who enrolled in business programmes at the Athens postsecondary area vocational technical school in Georgia either quit or were dismissed in the 12-month period of studies. Bassin and Sellner (1992) reported that only 58.9% of Bachelor of Science (Business Administration) students who entered the Shippensburg University, Pennsylvania programme in the fall of 1986 remained in the programme four years later.

From Canada, Anderson *et al.* (1994) reported that approximately 60% of the 4 500 students enrolling annually for the introductory economics course over all three campuses of Toronto University, were prevented from further study in economics because they either failed, dropped out, or did not obtain at least a C grade. Because of the perceived seriousness of the problem of attrition in Canada, a Commission of Inquiry on Canadian Education subsequently investigated the problem. The report by this commission stated that approximately 42% of all full-time undergraduate students who entered Canadian universities in 1985 failed to obtain a degree within 5 years (Johnson & Buck 1995).

Contrary to North America where it appeared to be routine for educational institutions to conduct studies of their rates of retention of students over time, little consolidated research into non-completion rates was available from the United Kingdom. It appeared as though a number of institutions had conducted 'in-house' surveys in recent years, but relatively little emerged into print. In a national study Johnes and Taylor (1989) investigated the differences between the undergraduate non-completion rates of different

UK universities. Using the 1979 and 1980 undergraduate entry cohorts they calculated a single measure of non-completion based upon the proportion of any given cohort of undergraduates who failed to complete their degree course at the university where they originally registered, using a six-year cut-off date (in other words double the minimum time needed to complete). The results reported indicated substantial differences between non-completion rates of different institutions (between 3.5% for Cambridge and 22.8% for Heriot Watt) and an average of approximately 13.5% for all universities per intake. The differences between different universities as far as non-completion rates were concerned were of interest. It was assumed that the low rate at Cambridge University could in part be attributed to the fact that greater competition for places would exist there than at perhaps less esteemed institutions. A high correlation existed between the non-completion rates obtained for the 1979 cohort and those obtained for the 1980 cohort.

Baumgart and Johnstone (1977) reported that the rates at which students discontinued their studies from higher education in Australia were 'unfortunately very high' and remained 'remarkably stable' in tertiary institutions. At Macquarie University in Sydney, for example, the rates remained fairly constant for each intake of new students since the university began classes in 1967, at values approaching 40% for undergraduate discontinuation. The authors mentioned that this rate of discontinuation was similar to rates at other Australian tertiary institutions.

From Nigeria, Young (1989) reported growing concern among the authorities of the University of Benin, especially the Science Faculty Board, about the continuing decline in the performance of students in their first year examinations. Failure rates at this university, for example, increased from 22.7% for the 1977/1978 intake to 52.2% for the 1980/1981 intake, while attrition rates increased from 6.2% in 1977/1978 to 12.6% in 1980/1981. Unfortunately the authors gave no definitions for the rates mentioned. It was assumed that 'failure rate' referred to actual subject failures, whilst 'attrition rate' referred to loss from the institution.

3.1.1.2 STUDENT ATTRITION IN MEDICAL SCHOOLS

Published results on attrition rates in medical schools were not easy to compare. This was primarily due to the fact that in the United States of America all medical students are 'older' in that they first complete pre-professional studies before selection into medical school. One would therefore expect that the academic failure rates of such students would be low as 'natural selection' has already taken place to a large extent during their first few years at college. Most other countries have a combined baccalaureate/medicine course where young school leavers are selected straight into medical school. One would expect that such first-time freshmen, despite the academic attributes that make them acceptable in a very competitive field, would tend to face more adaptation and personal problems than the academically more mature American students. One would thus expect higher attrition rates amongst such first-time freshmen.

However, a review of the literature on attrition rates in medical schools in the United States indicated that failures still occurred despite the very stringent screening methods employed by these schools. Croen *et al.* (1991) stated that despite careful reviews of applicants' academic records and letters of recommendation, medical schools each year accepted a number of students who encountered substantial difficulty in coping with the curriculum. They conducted a review of the attrition rates in 30 USA medical schools and found that 6.7% of the students had their graduation delayed or withheld because of academic failure.

Cariaga-Lo *et al.* (1997) conducted a study on all 658 students from the entering classes of 1987-1991 at the Bowman Gray School of Medicine of Wake Forest University. They categorized 5.5% of these students as failures (i.e. those experiencing attrition or academic difficulty) in the first year, with another 10.3% in the second year and an additional 1% in the third year. Considering the fact that these three years equate more or less to the third, fourth and fifth years of study in the combined baccalaureate/medicine courses in other countries, it can be argued that these reported attrition rates must be seen as high.

A large national study was undertaken by Koenig *et al.* (1998) on 11 279 students who entered medical school in 1992 and who took the United States Medical Licensing Examination (USMLE) Step 1 examination in June 1994. They reported a pass rate of between 88.9% and 96.8% for the different race groups, except for the African American students who showed a pass rate of only 69.3%. Again the attrition rate was high, considering the fact that all students must have completed pre-professional tertiary studies.

From those countries where medical students are selected straight from school, as is the case in South Africa, the published studies also indicated a serious problem. In the United Kingdom, Simpson and Budd (1996) attempted to assess the extent of the problem of attrition at the School of Medicine, University of Leeds. They conducted a retrospective analysis of the records of all students who failed to complete in the 10-year period 1983 to 1992. Reasons for leaving the course were assessed for each student and thereafter classified as academic failure, personal problems, or ill health. They also noted transfers to other courses if they were known. They reported that 14% of the students failed to complete the course. A possible criticism of this study (as with almost every other study reviewed) is the fact that the researchers only looked at non-completion rates, in other words those students who left the medical school without graduating. They gave no indication of the numbers of students (if any) who graduated behind their initial group. They also gave no indication of whether a particular year of study proved to be more problematical than other years.

In Israel, Lazin and Neumann (1991) investigated data for the first 10-year period (1974-1983) of the medical school at the Ben Gurion University, Beer-Sheva. They reported a permanent dropout rate (students who failed to complete their studies due to academic failure) of 12.6%, with another 11.2% dropping back (having delayed graduation). An additional 2.5% graduated on time, but at other medical schools. The figures reported for student attrition at Ben Gurion medical school were in actual fact averages and the actual figures at the time of reporting appeared to be much higher than those stated by the authors. A careful scrutiny of their paper indicated that for some reason the researchers

divided the 10-year period under investigation into 3 sections, namely 1974 to 1977 (4 years), 1978 to 1980 (3 years) and 1981 to 1983 (3 years). The percentage permanent dropouts as well as the percentage dropbacks over the first two reported periods (1974 to 1977 and 1978 to 1980) appeared to be within the averages quoted by the authors. However, for the last reported period (1981 to 1983), these figures more than doubled to 19% permanent dropouts and 23.1% dropbacks. This gave a total of 42.1% of medical students in serious academic difficulty over the period 1981 to 1983. This was a considerable increase over the average figures of 12.6% and 11.2% respectively quoted by Lazin and Neumann (1991).

Nnodim (1994) reported an average failure rate of 31.3% in first year anatomy for students at the Faculty of Medicine, University of Benin, Nigeria for the 5-year period 1989-1992. This result was not directly comparable to that of the other studies mentioned above, as it only reported on failures in a single subject. However, it must be remembered that anatomy is a major subject in most medical programmes and failure in anatomy would thus seriously affect total first year pass rates.

Unfortunately no publications which gave attrition rates from South African medical schools could be found. However, the literature reviewed indicated clearly that attrition rates from medical schools around the world were high, and there was no doubt this phenomenon was a source of serious concern.

3.1.1.3 STUDENT ATTRITION IN SOUTHERN AFRICA

Ayaya (1996) reported serious concern about the high failure rate in the B Comm programme at the National University of Lesotho. Average failure rates of more than 50% occurred in second, third, as well as fourth years of study in this programme. A criticism of this study is again the fact that no clear indication was given by the researcher of exactly what was meant by 'failure rate'. It appeared from the publication

as though failure rate was given per subject, and there was therefore no indication what the actual attrition rates were. According to the author the rates referred only to the first sitting of the end-of-year examination, which means that some of these students could still have passed the supplementary examination and thus the actual failure rate per subject may have been lower than stated. It would have been more appropriate perhaps to have indicated failure rates as the combination of the two examinations. It cannot be denied, though, that such high failure rates, particularly so in the more senior years, highlighted a very serious matter.

In an investigation on failure rates amongst first-year students at the University of the Transkei, Sawyer (1994) reported failure rates that exceeded 50% in six of the nine programmes examined. Sawyer defined a failure as a student who passed in no more than one subject, or no subjects at all in their first year of study at the University of the Transkei.

The definition of failure rate used in the Sawyer (1994) paper, i.e. to define success or failure per subject registered for, appeared to be common to a number of institutions in Southern Africa. In reality student failure rates could be much higher than indicated by such a definition. For example, a student who passed two subjects and was therefore classified as having passed by this method might actually have failed, or he/she may even have been an academic exclusion due to specific departmental or institutional rules. In some cases a student might for example only be allowed to 'carry' a number of first-year subjects to the next level, and in other cases the failure of a specific number of first year subjects might lead to academic exclusion.

The actual non-completion rates in South Africa appeared to be a reasonably well kept secret by tertiary institutions, unless it had simply not been seriously researched and quantified. Analyses of the studies that did mention pass rates, or alternatively non-completion rates, indicated that the problem in South Africa was also very serious. Only one study indicating the situation at a technikon was found. Fourie and Naude-De Jager (1992) stated that the failure rate in first-year physics for black students at all technikons

in South Africa during the 1988 academic year was 100% as compared to the 24% of all other students. In the 1989 academic year this figure was reported to be 67% as opposed to 6% for all other students.

The problem of attrition appeared to be particularly severe in engineering programmes. From the University of the Witwatersrand it was reported that approximately 35% of all first year engineering students failed the subject Engineering Analysis and Design. After the implementation of an academic support programme, however, this failure rate decreased to 22% (Potter & van der Merwe, 1993). Todd and Raubenheimer (1994) found that, on average, only 4% of the students who registered for an engineering degree at the Rand Afrikaans University completed the degree in the minimum period of four years. An evaluation of all 549 students who registered in the Faculty of Engineering between 1982 and 1986 indicated that a staggering 72.3% of these students never completed their engineering programme.

Ferreira (1995) reported that in 1980 nearly 30% of all registered undergraduate students at Pretoria University left the university without completing their studies. This highlighted the fact that student attrition in South Africa was a serious and ongoing problem. Ferreira (1995) listed some of the reasons commonly put forward for the increase in South African attrition rates. These included the facts that the transition from school to university was too drastic; that differences existed in approaches between school and university in that the school concentrated on the acquisition of knowledge whereas universities required the application of knowledge together with independent study; an unsatisfactory and rapidly deteriorating lecturer-student ratio where the large classes made individualized instruction impossible; and the fact that many students were first generation tertiary students.

3.1.1.4 CONCLUSIONS

The results as discussed above indicate that actual numbers or percentages from different published studies were very difficult to compare, as researchers tended to use different categorizations for students who discontinued their studies. Inadequate attention to definition often led researchers to lump together, under the categorization of dropout, forms of leaving behaviour that were very different in character. It was therefore not uncommon to find that researchers failed to distinguish between attrition resulting from academic reasons or from voluntary withdrawal. Most of the researchers also did not indicate how many of the students who were still in the system had experienced academic difficulty at some stage and thus fallen behind their peers to graduate late.

The attrition/ discontinuation rates as reported by numerous sources and discussed above, gave this researcher some indication of the extent of the problem of attrition around the world. It became clear that student wastage due to discontinuation (for whatever reason) deserved, in terms of sheer numbers, the urgent and concentrated attention of educational managers in general, and of this study in particular.

3.1.2 THE COST OF STUDENT ATTRITION

The cost of student attrition from an institution, or from a programme, must be seen in a much wider perspective than only from the very real financial side. Not only do discontinuing students suffer the psychological trauma of failure, but in many cases they will also have incurred financial obligations such as the repayment of student loans. Their discontinuation will, financially as well as psychologically, also affect their families, particularly so their parents or spouses. Discontinuing students also have serious implications for sponsors such as employers and grant-giving organisations, for

the government, and especially for the tertiary institution, which becomes less efficient from a cost-benefit perspective.

Many private American tertiary institutions that are tuition-driven, and therefore have to depend on large student tuition and alumni contributions, hold the position that it is easier to maintain existing students (customers) than to solicit new students. Many American tertiary institutions also depend on large grants and sponsorships from industry and thus have to ensure cost-efficiency in their institutional management. It is therefore routine for higher educational institutions in the USA to conduct studies on their rates of retention of students over time. As a consequence, a review of the available literature on this topic revealed considerably more individual institutional studies from the USA (Summerskill 1965; Campbell & Dickson 1966; Spady 1970; Tinto 1975; Pantages & Creedon 1978; Croen *et al.* 1991; Bassin & Sellner 1992; Cariaga-Lo *et al.* 1997; Koenig *et al.* 1998) than from the rest of the world such as Canada (Anderson *et al.* 1985; Anderson *et al.* 1994), the United Kingdom (Johnes & Taylor 1989), Australia (Baumgart & Johnstone 1977), Israel (Lazin & Neumann 1991), Nigeria (Young 1989; Nnodim 1994), Lesotho (Ayaya 1996), Transkei (Sawyer 1994), and South Africa (Fourie & Naude-De Jager 1992; Potter & van der Merwe 1993; Mitchell *et al.* 1994; Todd & Raubenheimer 1994; Ferreira 1995; De Villiers & Rwigema 1998).

Despite the large number of published studies on the topic of student attrition, very little information on the financial implications of student attrition was found. Although many studies on attrition mentioned the cost of education as a reason for undertaking such a study, none actually stated the costs involved. If institutions had conducted such costing studies, the results remained in-house without emerging into the public domain.

Most of the costs of students who do not complete the programmes of study for which they originally enrolled are not easily quantifiable without detailed empirical studies. One area of research that had also been given relatively little attention are studies aimed at establishing the cost to public finances of students who do not complete the programmes of study for which they originally enrolled. In a recent national study,

Yorke (1998) attempted to quantify the costs to the public purse of undergraduate non-completion in England for the academic year 1994/1995. Non-completion was simply defined as the failure to complete the programme for which the student originally enrolled. Data for the study were obtained from the institutional Higher Education Students Early Statistics Survey returns submitted. This study excluded teacher training colleges, as well as the Open University and the Universities of Oxford and Cambridge. These institutions were seen as 'atypical'. The study also excluded one institution that was 'grossly out of line' in the reporting of non-completion data to the Higher Education Statistics Agency. Despite the exclusions of these tertiary institutions, Yorke (1998) reported a staggering £91.5 million as the costs to the public purse of undergraduate non-completion rates for that single academic year of 1994-1995.

A view has to be taken regarding the proportion of a non-completing student's programme that should be taken as a cost. Yorke (1998) argued that, on the one hand, one must consider the fact that most students' experience of higher education was in some way beneficial, even if formal qualifications were not gained. At the opposite extreme it might be argued that if a student did not complete the course, all the public funds committed would have been wasted. From a governmental, an institutional, or even more so from a departmental view, it is unfortunately so that funds spent on a student who discontinues his or her studies must be considered as 'wasted' funds.

From a departmental and/or institutional viewpoint, student attrition will thus have a serious effect on the cost-efficient management of such a department/institution. With the reduced public funding per student (Melck 1999) and the financial crisis that existed in South African tertiary institutions over the last decade (Gourley 1992), this researcher was convinced that urgent measures would be required to reduce attrition rates.

3.1.3 WHEN ARE STUDENTS MOST AT RISK?

It is important for managers at tertiary institutions to be aware of the stage(s) in students' academic careers that could be viewed as "high risk" periods for non-completion of their studies. This will allow the institution to concentrate their efforts on reduction of attrition where it will have the largest impact on student retention rates.

In the United Kingdom, Johnes and Taylor (1989) conducted an investigation into the differences between the undergraduate non-completion rates of different UK universities using the 1979 and 1980 undergraduate entry cohorts. They reported that, for the university sector as a whole, around 53% of those who left did so within 15 months of entry. The proportion then declined exponentially until it approached zero in the sixth year after entry. A number of other researchers from around the world also found that the risk of attrition was highest in the first year and declined thereafter (Baumgart & Johnstone 1977; Pantages & Creedon 1978; Sawyer 1994; Johnson & Buck 1995; Simpson & Budd 1996; Cariaga-Lo *et al.* 1997).

Only one study was found from medical studies that reported on this aspect. Simpson and Budd (1996), in a retrospective analysis of all students who failed to complete their medical studies at the School of Medicine, University of Leeds in the UK, found that the majority of these students (87%) left during the first or second year of studies.

With the first year of tertiary studies emerging as the most dangerous from a non-completion point of view, institutions should therefore concentrate their retention efforts on this high-risk year. Successful completion of the first year of studies must have an encouraging and motivational effect on student morale and determination to continue. A study conducted by Johnson and Buck (1995) indicated that student psychological state appeared to be critically related to student-based undergraduate withdrawal. As indicated in Figure 4, students decide to withdraw from their undergraduate programmes on the basis of two main factors, namely academic performance and psychological state. During their studies, students generate a perception of the quality of their academic performance

and they evaluate that perception against a personal standard as well as against the standard set by the institution. Aitken (1982) stated that academic performance was assumed to directly affect withdrawal decisions not only because institutions set a minimum level of academic performance, which must be met in order for the student to remain in the institution, but also because the institutional measure of academic performance provided a direct message as to how well the student was doing relative to both the student's peers and an absolute standard. It therefore follows that, if success breeds success, then the fact that a student has successfully completed the first year of studies should have a very positive effect on his/her psychological state and thus on his/her further academic performance and commitment to graduation.

3.1.4 RACE AND ATTRITION

Personal student characteristics also listed in the Johnson and Buck (1995) model of student attrition (Figures 3 and 4) that often appeared in the literature as implicators of student attrition, were ethnicity, gender, and age. As far as gender and age were concerned, no clear pattern emerged from the literature. Although many authors indicated a difference in academic performance between older and younger as well as between male and female students, not much had been published about possible differing rates of attrition between these groups of freshmen. Where authors did address the issue of attrition, contradictory results were reported. For example, Huff and Fang (1999) found that female students were more at risk, while Jackson (1955), Simpson and Budd (1996) and Johnes and Taylor (1989) found that male students were at higher risk of attrition. Similarly, Simpson and Budd (1996) found that older (mature) students were not more at risk, whereas Huff and Fang (1999) found that they were more at risk of attrition. Bean and Metzner (1985) found that older, part-time students showed a higher rate of attrition, and stated that this might perhaps be because this group also showed lower high school grades.

However, a very clear relationship emerged between race and attrition. A review of the published studies indicated a much higher attrition rate for black students than for students of the other race groups. Tekian (1998) reported that diversity considerations in the United States of America had led to a substantial increase in the admissions of underrepresented minorities (URMs) to USA medical schools in the late 1960s.

According to the author, this change in the medical student demographic profile was then followed by a 'wave of increases in attrition rates' which, according to the Association of American Medical Colleges (AAMC) statistics had never been corrected to an acceptable degree.

In a national study undertaken to measure the predictive validity of the revised version of the Medical College Aptitude Test (MCAT) introduced in medical school selection procedures in the USA in 1991, Koenig *et al.* (1998) found that the pass rate for the African American students (69.3%) was considerably lower than that for other groups (88.9% and 96.8% respectively). At the same time they found that, on average, academic performance of the three racial/ethnic minority groups tended to be overpredicted by MCAT scores. This means that students belonging to these three groups were performing worse than expected whilst whites were doing slightly better than expected. This finding was particularly significant with regards to African American students.

A recent paper by Taylor and Rust (1999) also reported national attrition rates for USA medical students. For the group of students who matriculated in 1992, 85% of the non-minority (white) students graduated on time with the rest of their class. However, only 61% of the underrepresented minority group managed to do so.

Collins *et al.* (1997) reviewed the affirmative action experience over 23 years at the School of Medicine, University of Auckland, New Zealand. In total 147 students had entered the medical course at Auckland University through this programme. Of these students 75 graduated. Twenty-seven (18%) were lost from the course mainly through academic failure, which, according to the authors, was much higher than the 8% loss found for the remaining medical student population

McManus *et al.* (1996) reported from the United Kingdom that ethnic minority medical students were 2.09 times more likely to fail one or more examinations than were white students. Male ethnic minority students were also 1.65 times more likely to fail an examination than ethnic minority female students.

A number of other authors also found that black students (or other racial-ethnic minorities) were more at risk of attrition (e.g. Lunneborg & Lunneborg 1986; Ott 1988; Kerbeshian 1989; Tekian 1998; Huff & Fang 1999). In South Africa it was also well documented (Fourie & Naude-De Jager 1992; Mitchell *et al.* 1994; Ferreira 1995; De Villiers & Rwigema 1998) that students from disadvantaged academic backgrounds experienced greater difficulties in adapting to the tertiary education system and in being successful in their tertiary studies.

This fact has serious implications for South African tertiary institutions. With all such institutions rapidly changing their student demographic profile to reflect the racial situation in the country, large numbers of black underprepared students are entering tertiary studies. In 1992 already Fourie and Naude-De Jager (1992) pointed out the fact that the majority of future students in South Africa should be black and that important aspects of educational management, such as student selection at tertiary institutions as well as the identification of the student at risk of failing, would have to be geared towards the unique requirements and demands of black students.

Unless South African tertiary institutions implement drastic, and very costly, support measures, the influx of underprepared black students will certainly increase student attrition rates. Such students must not be allowed to register and then left to become attrition statistics. It would also not be ethical or fair to drop academic standards and so to provide an inferior tertiary education to such students. All tertiary institutions will have to understand that they have responsibilities towards the students that they admit into their programmes. This implies focus on the cognitive as well as the noncognitive development of the students, and on the financial implications of the necessary support and development programmes. In order to avoid student losses, or at least to minimize

the percentage students lost, the problem of attrition must therefore urgently be investigated and remedial action sought.

3.1.5 CONCLUSIONS

It was clear from the literature review that the problem of student attrition from tertiary studies was a serious phenomenon worldwide and that this impacted negatively on the cost-efficient management of the tertiary institutions. It is a known fact that the serious financial problems experienced by most South African tertiary institutions make it increasingly difficult for the institutions to subsidize students and the high attrition rate of particularly first-year students can no longer be afforded.

It was reported that in many cases staff at tertiary institutions did not appear to understand the seriousness of the problem of attrition and a general attitude existed that a tertiary qualification was simply not for everyone and that it was only natural to expect some students to discover their lack of interest or lack of suitability for university after a year or two of undergraduate studies (Johnson & Buck 1995).

With the increased call for accountability in higher education and for the more efficient and fair utilization of the nation's resources and of the available educational facilities, it is incumbent on members of the academic community to take seriously the determinants of successful outcomes in higher education. The fact that State funding per student is being reduced and tied increasingly to the attainment of stated targets, makes the whole issue of student attrition pertinent and the search for possible remedies essential. In future far more attention will be paid to measuring the performance of individual institutions for particularly funding purposes and one of the performance indicators for such an appraisal is bound to be the non-completion rates of students entering such a tertiary institution. It is thus imperative that management efforts be directed towards measures that will reduce or minimize student losses.

The clear indication in the literature that the first year of studies is the most dangerous from a non-completion viewpoint makes it imperative that institutional efforts at management of attrition be directed towards the high-risk freshman year.

3.2 MANAGEMENT OF ATTRITION

The literature reviewed indicated very clearly that attrition was a serious and costly problem and that measures that would reduce student losses to an acceptable minimum were urgently required. A scrutiny of the theoretical models of attrition (Spady 1970; Tinto 1975; Johnson & Buck 1995)(Figures 1 to 4) indicated that two phases should be identified in any attempt to manage the problem of attrition. The first phase of management of attrition was the pre-registration period, whilst the second impact phase was the post-registration period.

3.2.1 MANAGEMENT OF ATTRITION: THE PRE-REGISTRATION PERIOD

The period before a student registers for a particular programme at a tertiary institution is very important both from the student's as well as from the institutional point of view. During this time the student will go through the process that will eventually lead to a final career decision and a decision of the institution of choice for further studies. From the institutional side it includes policies and decisions on which students to register for specific programmes. Once both sides have committed themselves, registration can take place.

Of the two phases implicated in the management of attrition, this pre-registration phase must, undoubtedly, be seen as of the most value. If only the “correct” cohort of students could be enrolled into a programme, so that they are all successful in their studies whilst still possessing the required personal characteristics for their chosen career and with imbalances of the past being redressed at the same time, then the problem of attrition should be minimal. Admission of students into different programmes is thus the major way by which student attrition can be managed in this pre-registration phase.

Admission into tertiary studies can occur at different levels. Admission into American medical schools, for example, takes place after completion of pre-professional tertiary studies. In most cases, however, admissions into tertiary studies take place straight after completion of secondary schooling. In some cases admissions for underprepared applicants can also take place via alternative procedures such as the use of admissions tests and bridging years, to mention just a few. However, it must be accepted that tertiary education is too costly to be made available to all applicants and therefore some form of student selection will always have to take place in order to allocate scarce places.

3.2.1.1 STUDENT SELECTION

Selection of a cohort of freshmen from a large number of applicants is complex, fraught with uncertainty and inevitably accompanied by logistical difficulties (Powis 1994).

Student selection actually implies that only those students with a predetermined probability of success will be allowed to register for a specific programme (Miller 1992). The selection of students could thus in this context be seen as synonymous with the identification of students who will be at risk of failing and through selection procedures, students at risk are then by implication eliminated (Fourie & Naude-De Jager 1992). This is a very difficult task. A scrutiny of the theoretical models of attrition and particularly those of Tinto (1975) (Figure 2) and Johnson and Buck (1995) (Figure 4)

indicates that a wide range of personal and academic variables characterizes individual students and that they bring these characteristics with them to the institution. Against this background, how does a selection committee decide which students to select into a tertiary programme?

Student selection has two important aspects. It is firstly a problem affecting the students, who, when selected, might see their selection as an indication from the institution that they have the ability to pass and failure for them therefore might mean not only a financial loss, but could also be psychologically very traumatic. Student selection is secondly, however, also a problem affecting the institution as far as pass rates are concerned, since funding is often affected by pass rates. Also, as all freshmen carry the same unit cost (expenditure per student) to the department/institution, it must be accepted that all funds spent on a student who discontinues his or her studies could be viewed as wasted funds. Students who discontinue their studies due (even in part) to unrefined selection procedures, thus represent a serious problem to the institution. This is not only because of the resultant inefficiency of the institution in cost-benefit terms, or because of the fact that each unsuccessful student theoretically keeps a potentially successful student out of tertiary education, but also because of ethical considerations in respect of the futures of individuals who discontinue.

Much attention has thus been focused on selection into tertiary studies in order to find the “best” students and so to maximize the enrollment capacity of the system. If all entering freshmen possessed the minimum preparation necessary for a successful tertiary experience, it would reduce the inefficient use of staff and resources for remedial activities that could be more effectively carried out in a non-tertiary setting. If unit costs could be kept down, then with the same amount of financial resources it should be possible to expand access to higher education by increasing enrollments while at the same time ensuring acceptable academic standards.

3.2.1.1.1 SELECTION IN MEDICAL SCHOOLS

The problem of student selection becomes even more difficult when selecting students for medical schools and for medical-type studies such as chiropractic and homoeopathy. In recent years, there has been much discussion about the advantages and disadvantages of different selection methods. Research in this area has also increased, and as a consequence there has been increasing pressure for reforms in selection methods around the world. As stated by Powis (1994), medical schools have to judge what kind of skills medical students should possess and how they could select such students. The task of selecting for medical-type studies is so difficult because the field of study is very extensive and includes different subdomains that may vary in terms of what kinds of study approaches and strategies are useful. Medical studies take many years, too, and students go through different phases of learning during this time. In sum, the objective should be to select students who would do well both in studying and in the profession. (Lindblom-Ylänne *et al.* 1996.)

A review of the literature spanning more than 50 years indicated that efficient and effective selection of medical students apparently remained an unsolved problem as a recent publication still reported the need for change (Marley & Carman 1999). According to Walton (1994) selection of entrants to medical school is 'one of the most troubled areas in the whole of medical education'. The literature on the subject is enormous and there is a vast methodological contribution from the sciences of psychology and sociology. Experience in the field of selection in the 1 500 medical schools around the world is massive and, unfortunately, largely undocumented. Controversies as to selection of medical students have riven the field and have existed throughout history. The conflict was apparently already fierce in Ancient Greece. On the one hand, the Cnidians believed that almost anybody could become a doctor, as training would predominate over the inherent attributes of the entrants. On the other hand, Hippocrates at Kos was adamant that doctors 'were born'. He thus believed it crucial that entrants be selected. (Walton 1994.)

Although world medical education opinion is now almost totally convinced that selection is essential, medical schools in many countries around the world are still practising an open entry policy. The initial years at medical school (often the basic science period) are then unfortunately used for 'selection by dropout'. Walton (1994) criticized this policy most strongly and stated that it implied a 'wicked waste of young human talent greatly needed in other sectors of community life'. He also argued that this practice neutralized the educational value of the initial years of study instead of using this valuable time positively for the training of a country's doctors.

In discussing selection of medical students, Powis (1994) suggested that medical schools needed to create and implement efficient and effective selection policies in order to discriminate between large numbers of applicants. Such a selection policy should, ideally, contain firstly a statement describing all the qualities (academic and non-academic, cognitive and non-cognitive, as well as demographic) that the specific medical school would expect of its students. These would be the qualities that would ensure that the students would be able to cope with and be successful in the specific course of studies offered at that institution and would at the same time ensure that good doctors enter into the profession. Secondly, the policy should also contain a list of valid, reliable and acceptable tools or methods that could be applied by admissions staff to identify such desirable qualities.

A selection policy, such as the one suggested above, should be essential, not only at medical schools, but also at all institutions of higher education. Unfortunately this type of selection policy seldom exists in practice, often because institutions or professions do not explicitly define the qualities required. Powis (1994) also mentioned that, even if a selection policy 'adequately' defined required qualities, the institution often did not use the most appropriate methods for the identification of such qualities, usually because such methods are costly or time-consuming to use. Even more importantly, even if all such methods were also in place, very often medical schools (and other tertiary institutions) were subjected to pressures or other outside influences that seek to modify the selection process (Powis 1994).

Walton (1994) indicated that the chief method used worldwide for screening applicants to medical school was the use of cognitive data. Most medical students, and hence doctors, thus enter the medical profession on grounds of their intellectual ability, as expressed in school-leaving examination results and academic performance data (e.g. Bean 1980; Mohammad & Almahmeed 1988; Montague & Odds 1990; El Mouzan 1992; Collins & White 1993; Collins *et al.* 1995; Simpson & Budd 1996; Marley & Carman 1999).

Walton (1994) reported that serious concern about the selection of medical students by academic score alone had been voiced by policy makers, medical educators, and the public, and doubts about this procedure were also expressed by Marley and Carman (1999). Montague and Odds (1990) described the undergraduate medical course as a vocational course that required and deserved highly motivated recruits with appropriate personal qualities. However, the course was also academically demanding, both in terms of the breadth and depth of the material to be covered, and academic ability should therefore be high on the list of selection criteria. For those medical schools that selected students straight from school, adoption of school examination achievement based on the intellectual component of personality (the cognitive aspect) seemed to be the simplest system of selection in operation (Young 1989; Bokhorst *et al.* 1992; Neame *et al.* 1992; Collins & White 1993; de Vetta 1993; Green *et al.* 1993a; Green *et al.* 1993b; Tutton 1993; Mitchell *et al.* 1994; Powis 1994; Sawyer 1994; Collins *et al.* 1995; Jawitz 1995; Ayaya 1996; Simpson & Budd 1996; Bargate 1999). In many cases specified subjects also contributed more to the aggregate score used for selection purposes (e.g. physics, chemistry, or mathematics), or applicants were required to have taken specified subjects during schooling (Collins *et al.* 1995). Medical student selection based mainly on cognitive data often resulted in the selection of applicants from the top 1% to 3% of academic achievers (Collins *et al.* 1995).

In this single criterion approach admission into medical school was thus denied to equally capable secondary school students due to the inevitable margin of error around the cut-off mark. Such a singular approach also excluded many applicants with outstanding personal qualities and achievements. In an attempt to force institutions to address this problem

and to change their selection policies, the World Conference on Medical Education in 1988 formulated its Edinburgh Declaration. The eighth principle of this Declaration, which was subsequently endorsed by the World Health Assembly on 19 May 1989, affirmed that selection of entrants should be based on non-cognitive as well as intellectual attributes (World Conference on Medical Education 1988).

Unfortunately no consensus appeared to have been reached about the right method for appraising non-intellectual attributes of applicants. Thus the World Summit on Medical Education five years later called for a still more explicit reform. The eighth recommendation of this global consultation (World Federation for Medical Education 1994:165) again focused on academic and non-intellectual characteristics:

The principles of selection should be clear, equitable and valid. Medical schools should design criteria that address both academic and non-intellectual characteristics, such as social commitment and minority status. Attitudinal assessment techniques should be studied in every medical school for validity in identifying the necessary non-cognitive qualities in would-be entrants.

Despite this strong call to reform, it is not that easy to design admission criteria that address both academic and non-academic characteristics. Many medical schools appeared to use the student's previously proven academic record as an initial filter (Whitehouse 1997) and then to use a combination of other selection criteria to make their final selection (El Mouzan 1992; Collins & White 1993; Tutton 1993; Collins *et al.* 1995; Meleka 1995).

It appeared as though the selection interview was one of the most popular selection procedures used in an attempt to assess the non-intellectual characteristics of applicants. Elam *et al.* (1994) reported that over 95% of medical schools interviewed candidates as part of their selection processes, and that nearly all of them conducted semi-structured interviews with all candidates. Interviews were used as a source of information about the

applicants' motivation and interest in medicine, their personal characteristics and their interpersonal and communication skills.

Having reviewed the available literature on the selection interview, Edwards *et al.* (1996:3) summarized the four purposes for interviewing applicants to medical school as follows:

- * gathering information;
- * making the decision to accept or reject;
- * verifying information provided in the application;
- * recruiting particular applicants.

Edwards *et al.* (1996) suggested that the gathering of special information might be the most important purpose of interviews. They argued that, whilst quantitative information, such as transcripts and background information, was better gathered by paper or by computer, information on a student's motivation, leadership, altruism, and interpersonal skills was best evaluated in interviews. They concluded that the interview could be particularly useful in selecting among all the academically qualified applicants those who most closely matched the desired characteristics or the ethos of the medical school. This conclusion tied in with the statement by Powis (1994:443) that a medical school, when faced with large numbers of applicants, needed to create and implement '*an efficient and effective selection policy*'. In order to find those applicants with the desired characteristics the admissions committee was required to have done some careful analysis of the criteria for selection and for interviewing. In the researcher's view, structuring of the interview appears to be the most productive method of ensuring that the applicants who are most desirable are, in fact, chosen.

Studies examining both the reliability and validity of the medical school interviews received minimal research attention. Particularly the validity of the admissions interview was of major concern. In a recent review article Morris (1999) reported that 'despite the widespread popularity of the admissions interview, its use is controversial'. He came to the conclusion that results of studies into the fundamental issue of whether the

admissions interview was a reliable, valid, fair and useful tool were equivocal. It appeared as though medical schools which interviewed applicants could justify continuing to do so and those who did not could also justify not using this process. The question that now arose was whether the enormous time and resources spent on the admissions interview in order to distinguish between applicants were justified. Walton (1994) argued that it was a popular method, valued by medical teachers 'because they have faith in their own judgement'. He also commented that both interviewers and applicants appeared to get satisfaction from interviews, that interviews were good for public relations, and that they conveyed the message that concentrated individual attention was given to applicants. Perhaps these are good enough reasons for an argument supporting the use of the interview as part of the selection process.

However, what did emerge from a scrutiny of the available literature on the selection of students into medical school, was the unwelcome fact that the problem remained largely unsolved (Marley & Carman 1999).

3.2.1.1.2 CONCLUSIONS

A scrutiny of the available literature on student selection into tertiary institutions indicated that a wide variety of selection procedures (either singly or in various combinations), as well as a wide variety of student characteristics were being employed to make final decisions on who to admit into the educational programmes. In some institutions informal reviews and personal judgements appeared to be the main ingredients of the admissions process, whilst in others highly structured mathematical processes were used. No selection method apparently had yet been distinguished by its success, as the attrition rate around the world continued to be a source of concern. The shortcomings of the subjective methods were more obvious as it was reported that the interview might sometimes be unstructured or hurried, or it also appeared as though the interviewers had often not been adequately trained (Elam *et al.* 1994; Glick 1994; and

Johnson *et al.* 1998). Because of these reasons, important indicators of possible success might thus have remained uncovered.

Both cognitive and non-cognitive student characteristics were explored in an attempt to find those students who would not only have a fair chance at passing, but who would also eventually make the best professionals in the career that they would be trained for. In order to increase student diversity, different selection methods for different target groups were also used (e.g. Miller 1992; Collins *et al.* 1997; Tekian 1998; Zaaïman *et al.* 1998, Botha & Cilliers 1999; Dawes *et al.* 1999), and some institutions initiated development/bridging programmes to try and bring educationally disadvantaged students to a level where they could cope with tertiary studies (Craig 1992; Griesel 1992; Yeld & Hartman 1992; Venter 1995).

Observation has shown that, in an attempt to reduce attrition rates and to improve student retention and performance, the process of selection and evaluation of high school students for the scarce openings in tertiary programmes goes on continuously. The mere implementation of a particular method(s) of selection does, however, not ensure that the required outcome will be achieved. The effectiveness of any admissions strategy cannot be judged until properly researched and tested for correlation with university performance or with successful completion of the programme.

3.2.1.2 EVALUATING SELECTION STRATEGIES

In the evaluation of selection strategies, two approaches can be taken. Firstly, it would be beneficial to an institution to be able to predict a student's future academic performance by making use of data that are available at the time of selection, and particularly from those student characteristics that the institution places emphasis on in the selection process. Students can then be ranked according to predicted future performances and the "best" students can be selected for the programme. On the other hand, eventual

percentages scored by freshmen are by no means the only consideration of importance to selectors. With student attrition from tertiary institutions presenting such a serious problem, it would be of much more benefit to an institution to be able to predict whether applicants will be successful or not successful in their future studies. Prediction of academic outcome should therefore receive serious research attention.

In the following literature review the published studies were therefore separated into firstly those studies that attempted to predict actual academic grade performance, and secondly those studies that attempted to predict academic outcome, i.e. pass or fail.

3.2.1.2.1 PREDICTION OF ACADEMIC PERFORMANCE FROM PRE-REGISTRATION CHARACTERISTICS

The structured research in this field was most often an attempt to predict future results from prior data. The possibility of accurately predicting a student's academic performance received a lot of attention because, if characteristics of incoming students can be shown to be reliable predictors of their ultimate performance in tertiary studies, then students and departmental/institutional resources could be more efficiently allocated by excluding students with low probabilities of success. What is even more important in this time of stringent financial resources, is that the results of prediction studies could be used to design admissions policies in order to minimize the loss of those students most likely to succeed.

The huge body of research that exists on the topic of prediction of academic performance is an indication of the importance placed on the ability to select students who will ultimately perform well academically. The studies varied from simple correlations to very sophisticated multiple regression and discriminant analyses. A very large number of variables (both cognitive and non-cognitive) that might be involved in a student's academic performance has been utilized in these statistical analyses.

3.2.1.2.1.1 COGNITIVE VARIABLES

By far the majority of researchers have concentrated on cognitive variables in their research. As previous academic records of applicants are readily available at time of selection, the ability to use such information in the selection process at no extra cost to the institution must remain the “best” and most sought after option. Even the possibility of using results from entrance tests to predict tertiary performance appeared to be very popular, particularly where institutions were faced with applicants from diverse educational backgrounds which could not easily be compared. In such cases an admissions test provided a standardized metric on which all applicants could be judged equally. A very well known example of such an admissions test used widely throughout the USA is the Medical College Admissions Test (MCAT). Admissions decisions based on such a standard metric thus provided some rational basis for selection decisions by the medical schools. The information from the MCAT was usually used in conjunction with other information such as grade averages. The MCAT as a standardized admissions test was also seen to provide some basis for fairness in the admissions process. Irrespective of country of origin, ethnic grouping, or institution of pre-medical studies, each candidate would, by this process, have a fair opportunity to demonstrate achievement on the admission test and therefore be eligible for a position at the medical school. Without such a standard metric admission criterion, students could be subject to a number of discriminatory practices that would have no bearing on their potential to succeed in the relevant position (Association of American Medical Colleges 1993; Xu *et al.* 1993; and Violato *et al.* 1996). The ability to correctly predict student performance from the results scored on such admissions tests was thus seen as very important.

The literature review indicated that the validity of any pre-registration characteristic (predictor variable) was usually investigated by examining the size of its correlation (or the square of the correlation) with the academic performance of the student (the criterion variable). Where pre-professional qualifications had to be obtained before registration, as in the USA, the most frequently used cognitive predictor variables appeared to be undergraduate grade point average, as well as aptitude tests such as the SAT and MCAT.

In South Africa, school results, either the scores obtained in individual matric subjects or points score, were the most popular. Criterion variables of choice in the USA were mostly the freshman grade point average and in South Africa they were either the mean of the percentage marks obtained for the courses in the student's first year, or the number of credits earned during the first year.

Considering the results from the plethora of published studies investigating the use of cognitive data as predictors of tertiary performance (starting as early as 1905 as reviewed by Garrett (1949)), the importance of academic predictors of performance at tertiary institutions, and particularly the value of school results in this regard cannot be ignored. Only three researchers (Rees 1981; Button & Fleming 1982; Zeidner *et al.* 1990) found that school results had no significant predictive value whatsoever, while researchers such as Roessler *et al.* (1978), Lazarus and van Niekerk (1986), Barker (1989), Johnes and Taylor (1989), Kanoy *et al.* (1989), Zeidner *et al.* (1990), Bullimore (1992), El Mouzan (1992), Collins and White (1993), Tutton (1993), Glick (1994), Collins *et al.* (1995), Larose and Roy (1995), Edwards *et al.* (1996), Cariago-Lo *et al.* (1997), Shen and Comrey (1997) and Whitehouse (1997) advocated a combination of cognitive and non-cognitive variables when investigating factors that could be useful in student selection and retention. In scientific studies, and particularly in medical schools, some minimum academic threshold appears to be of universal importance. This minimum threshold appeared to be mainly based on secondary school results (Young 1989; Bokhorst *et al.* 1992; Neame *et al.* 1992; Collins & White 1993; de Vetta 1993; Green *et al.* 1993a; Green *et al.* 1993b; Tutton 1993; Mitchell *et al.* 1994; Powis 1994; Sawyer 1994; Collins *et al.* 1995; Jawitz 1995; Ayaya 1996; Simpson & Budd 1996; Bargate 1999), and results obtained by the majority of investigators indicated that previously proven academic ability, as shown by high school results, was the single most important predictor of tertiary success (Scannell 1960; Arnold *et al.* 1983; Sear 1983; Lazarus & van Niekerk 1986; Nettles *et al.* 1986; Foy & Waller 1987; Touron 1987; Fulton 1988; Mohammad & Almahmeed 1988; Ott 1988; Barker 1989; Johnes & Taylor 1989; Montague & Odds 1990; Lazin & Neumann 1991; Bokhorst *et al.* 1992; El Mouzan 1992; Green *et al.*

1993a; Green *et al.* 1993b; Simpson & Budd 1996; Lumb & Vail 1997; Shen & Comrey 1997).

The majority of the authors thus agreed that, at least for the student from an educationally advantaged background, school results were good predictors of success with the highest correlations found with the scientific subjects and languages (e.g. Montague & Odds 1990; Tutton & Wigg 1990; El Mouzan 1992; Nnodim 1994; Collins *et al.* 1995; Lunt 1996; Till 1999). The results also indicated that the majority of significant correlations tended to cluster towards the start of university studies.

Although the overwhelming majority of studies showed that cognitive measures were good predictors of academic performance, a number of authors reported that this was not the case for students from different ethnic groups, and particularly not for black students (Lunneborg & Lunneborg 1986; Ott 1988; Bokhorst *et al.* 1992; Charupatanapong *et al.* 1994; Jawitz 1995; Rodriquez 1996; Koenig *et al.* 1998; Zaaïman *et al.* 1998; Botha & Cilliers 1999). Some authors even excluded students of different ethnic groups from their studies because '*their poor performances on all criteria would confound the calculated relationships*' (Shen & Comrey 1997:781). On the other hand, two studies conducted at predominantly black universities reported that school results were predictors of academic performance for black students (Sawyer 1994; Ayaya 1996; Dawes *et al.* 1999).

It appeared from the published studies that, although academic criteria alone may not be able to identify the required non-cognitive attributes that might be required in programmes such as medicine, they do provide to some extent an intellectual safety net.

3.2.1.2.1.2 NON-COGNITIVE VARIABLES

The theories of attrition (Spady 1970; Tinto 1975; Johnson & Buck 1995) (Figures 1 to 4) indicate that an individual applicant to a tertiary institution has a very large number of

personal characteristics, all of which will eventually play a role in that student's academic performance. The selection of students on cognitive grounds alone can therefore not be accepted. The conclusions drawn from the literature review on the predictability of cognitive variables also indicated very clearly that cognitive variables were not good predictors of academic performance for underprepared and particularly for black students. This fact is of great importance to South African tertiary institutions where the majority of applicants are black and from disadvantaged educational backgrounds. Strong attention must thus be focused on the evaluation of selection strategies based on non-cognitive student characteristics.

As early as 1949 Garrett (Garrett 1949: 120) wrote '*Although admirable progress has been made in discovering and attempting to measure the factors which contribute to scholastic success in college, ... there remains a unique, unmeasurable factor, or perhaps many factors, lost in the unpredictable intricacies of human personality*'. Therefore, in addition to assessing the academic skills of incoming students for placement purposes, institutions must also look towards the non-cognitive characteristics of applicants in an attempt to more accurately predict student performance in higher education.

A number of non-cognitive variables have been identified as being related to academic achievement and a large number of studies (the majority emanating from the USA) have investigated the effect of such variables on actual classroom performance, with varying results. Because of the serious need that exists in South Africa (as well as around the world) to find non-cognitive variables that could be used effectively in the selection process, the studies in this section were given much attention.

(i) Abroad

In his very early review, Garrett (1949) tried to interpret the studies addressing factors related to scholastic success in Colleges of Arts and Science and Teachers Colleges published between 1905 and 1948. He reported that results of these studies indicated that tests of personality in general showed practically no correlation with college grades.

Garrett stated that it appeared as though no test of personality or character had been devised up to that time which could predict to any appreciable extent, the scholastic success of a student in college.

Holland (1959) reported on a study using very high aptitude students and designed specifically to explore the usefulness of non-intellectual factors in predicting college grades. The study sample consisted of 743 Merit Scholars and 578 Certificate of Merit winners drawn from a sample of 7 500 finalists, the survivors of a nationwide competition in which 166 000 high school scholars participated. These students had enrolled in a number of different colleges in the USA. All the students had completed the California Psychological Inventory (PSI) a month before the start of their freshman year and the Scholastic Aptitude Test (SAT) had been administered to all the students about 7 months before the start of the semester. Because of their overall psychometric and demographic similarity, these two groups of students were combined and then randomly sorted into two separate groups. Data from the first subgroup were used to develop regression equations and the second subgroup was used as a cross-validation sample. Male and female students were analyzed separately in both groups.

As criterion variable the researcher used freshman grades in college, or honour point ratio (HPR). The grading system of all the colleges in the study were converted to HPR by means of a standard formula used by the majority of the institutions. The results of this study showed that for the SAT, the Verbal and Math factors appeared to be about equally efficient in predicting grades. For the CPI, the Social Presence, Socialization, Responsibility, Achievement via Conformance, as well as the Femininity scales had useful predictive validity, both alone and in combinations with SAT. The Social presence and Socialization scales appeared more efficient, since they were significantly related to grades for all four total samples across colleges. The author suggested that achievement and underachievement among gifted persons was a specific facet of the general problem of socialization. The author concluded that the CPI could enhance the predicting ability of the SAT. Despite the good correlations found between some of the CPI scales and academic achievement, the author mentioned the fact that the individual

scales in the CPI instruments showed wide variation in validity from college to college. Together with the problems of obtaining valid measurements of the characteristics another important fact mentioned was that when they were sitting for the CPI, the students were aware of the fact that the result was not going to be used as a screening device for selection purposes.

A review by Margrain (1978:111) of the literature on student characteristics and their predictive potential for academic achievement delivered results that were '*not optimistic (and) often contradictory*'. The author reported that the reviewed studies indicated that, on the whole, student characteristics accounted for little variance beyond that accounted for by tests of intellectual ability. Despite the fact that much complex, diverse, and unique work had been done on personality and motivational factors, no clear trend emerged at that time which could point towards the use of some of the characteristics as predictors of tertiary academic performance. The author therefore concluded that, although the interaction and grouping of a number of student characteristics appeared to result in a more complete picture of the successful student, the correlations involved were often very small and the idiosyncratic variable appeared to lie with the investigator and the study.

The result reported above was similar to that of Entwistle and Entwistle (1970) who, using students from universities, polytechnics, and colleges of education, found that the addition of other characteristics only boosted the correlation between A-level results and academic performance by 0.06.

Gough and Lanning (1986) designed a study to assess the predictive ability of the California Psychological Inventory (PSI) on college grades. The aim was to see if a general or forecasting index could be developed and the study evaluated the predictive power of the CPI, not only on first-year GPA, but also on two-year GPA, four-year GPA, and performance in single courses, for students from a variety of schools and classes.

The samples assembled for this study were classified into 3 different groups. The first included 1 887 (725 male and 1 162 female) introductory psychology students at Berkeley in the USA. The academic criterion for this sample was course grade in introductory psychology. These students were tested between 1950 and 1978. The second group consisted of 198 students (99 male and 99 female) who were tested between 1979 and 1984. For these students, the criterion was the two-year GPA. The third group was composed of students at four other colleges for whom four-year GPAs were available. In three of these colleges students took the CPI as entering freshmen and in the fourth college students were tested early in their senior year with the GPAs obtained a year later. For cross-validation, 326 male and 570 female students from two introductory psychology classes at Berkeley taught by the same instructor were used.

Correlations between the CPI scales and the standardized measures of academic performance in the initial and validating samples indicated the highest median coefficient ($r = .28$) with the "Achievement via Independence" scale. The next largest median ($r = .25$) was for the "Intellectual Efficiency" scale, and the third ($r = .23$) was for "Psychological-Mindedness". The authors explained that the magnitude of the last coefficient might reflect the fact that students in introductory psychology classes made up over half of the study sample. Stepwise multiple regression analyses were then conducted on the data from the total initial sample of 3 189 students to identify the best combination of scales to forecast GPA. Six CPI scales were retained in the final equation, namely "Sense of Well-being", "Responsibility", "Good Impression", "Achievement via Independence", "Intellectual Efficiency", and "Psychological Mindedness". Scores computed from this equation on initial male students had a correlation with grades of .34 and those of females a correlation of .31. On the cross-validating samples, the equation produced a correlation of .38 for the males and .36 for the females. The authors commented that the common sense observation that motivational and dispositional factors always play a role in any real-life setting, suggested the consideration of personality variables such as those that are scaled on the CPI. They concluded that from the evidence suggested by their results, it appeared as though a relatively simple combination of scales on the CPI could produce forecasts of

collegiate academic performance that were comparable in accuracy to those based on aptitude measures. They did agree, however, that accuracy of forecasts could be improved by using both sources of information.

The personological portrait of the high-potential college student that emerged from the equation thus incorporated themes of self-discipline, independence, and relative freedom from egoistic or self-aggrandizing moves.

Kanoy *et al.* (1989) used both traditional and nontraditional measures in order to determine the best predictors of academic achievement with the freshman student's second semester GPA as the criterion variable. They also aimed to evaluate whether the best model for predicting achievement would contain different variables for students who were expected to do well in college (around 3.0 to 3.5 based on predicted GPA) and those expected to perform in the 2.0 range. The study sample consisted of 70 freshman females entering Peace College, a small, liberal arts college in North Carolina. The students were divided into two groups based on their predicted GPAs for college work as calculated by the admissions office from a formula provided by the Educational Testing Service which included SAT scores, Test of Standard Written English scores and high school GPAs. Apart from the traditional measures (SAT scores, Test of Standard Written English scores and high school GPAs), they also used cognitive complexity, locus of control, academic self-concept, and effort to predict the freshman-year GPA of the women in the study. Multiple regression analyses were used to determine the best predictors of GPA for both groups.

The results of the study indicated that, for the group expected to do well in college, the high school GPA and academic self-concept formed the most powerful model and predicted 56% of the variance in GPA. For the group with a lower predicted GPA, none of the traditional predictors was effective in predicting freshman year GPA. For these students, two psychological variables, namely internal locus of control for achievement success and amount of effort put into their work, accounted for 46% of the variance in

GPA. In other words students who took more responsibility for their successful academic experiences performed better in the classroom.

A more recent study (House 1995) evaluated non-cognitive predictors of achievement in introductory college chemistry at Northern Illinois University. The purpose of the study was to investigate the predictive relationship between initial student attitudes, admissions test scores, high school curriculum, and subsequent achievement in college chemistry. Students included in the study were a sample of 179 students who began as new freshmen at Northern Illinois University. All students were admitted to the university through the regular admissions procedures. The students in the sample were randomly selected from the population of freshmen who took an introductory chemistry course during their first year of college. During an on-campus orientation period before the start of their freshman year, all students were requested to complete a survey that included several items that measured students' self-ratings of their academic abilities and their expectancies for academic achievement. For use in this study, four academic self-concept items were included. These were self-rating of overall academic ability, drive to achieve, mathematical ability, and students' self-confidence in their intellectual ability. In addition, two items that measured students' achievement expectancies were selected for use in this study. These were expectations of earning at least a B average in college and expectations of graduating with honours. The dependent measure used in the study was the grade earned in an introductory chemistry course taken during the first year of college. Grades for this course were assigned using a traditional four-point scale. The data from this study were analyzed in different ways. Firstly correlation coefficients were computed to examine the relationships between each of the predictor variables. Then correlation coefficients were computed to determine the relationships between each predictor variable and subsequent grade performance in introductory chemistry – also separately for male and female students. The correlations obtained for male and female students were then tested for any significant differences using a Z-transformation procedure. Least-squares multiple regression analyses were used to determine the relative ordering of student attitudes, a measure of prior cognitive achievement (ACT Composite scores), and a measure of prior instructional experience (the number of years

of high school maths that were completed) for predicting chemistry achievement. Multiple regression analyses were performed for the entire sample and separately for male and female students. In order to examine consistency in the ordering of the predictor variables, a cross-validation analysis was performed where the sample was randomly divided into two and multiple regression analyses were performed for each subsample. Similarities and differences between the two cross-validation samples for ordering of the predictor variables were examined.

Correlations between each predictor variable and subsequent chemistry grades for the entire sample indicated that only one predictor variable (expectations of making at least B average in college) was not significantly related to later grade performance. Separate analyses for male and female students showed only one significant difference. It was shown that the relationship between expecting to make at least a B average in college and later chemistry achievement was significantly stronger for male students than for female students. The multiple regression analyses using both cognitive and non-cognitive variables as predictors of grade performance in chemistry for the entire sample indicated that two variables, namely self-rating of mathematical ability and overall academic ability, entered the regression equation significantly. The overall regression equation for all students was significant and explained 25.4% of the variance in chemistry grades.

The results of the cross-validation analyses indicated that in the first cross-validation subsample, ACT composite scores also entered the regression equation significantly while in the second subsample only self-rating of mathematical ability significantly entered the regression equation. Both cross-validation subsamples produced significant overall regression equations and explained 35.8% and 20.9% of the variance in chemistry grades respectively. When analyzed by student gender, self-rating of mathematical ability entered the regression equation first for female students while self-rating of overall academic ability entered the regression equation first for male students. In addition, self-rating of mathematical ability and drive to achieve also entered the regression equation significantly for male students. It could be seen that ACT scores and years of high school math taken did not significantly enter the regression equations for male and female

students. For male students the overall regression equation was significant and explained 41.9% of the variance in chemistry grades while for female students the equation was also significant but only explained 20.3% of the variance in the chemistry grades.

A finding from this study was that self-ratings of mathematical ability were significant predictors of earning a grade C or higher while the number of years of high school math taken was a significant predictor of earning a passing grade (D or better). These results indicated that there was a set of minimum mathematical skills necessary for passing introductory chemistry and that initial attitudes became significant predictors only for students who had the prerequisite mathematical skills. The author concluded that students' initial attitudes were significant predictors of their subsequent grade achievement in college chemistry.

Wolfe and Johnson (1995) investigated personality as a predictor of college performance. They reported that admission to many colleges and universities was traditionally determined by the applicant's scholastic record in high school and performance on the Scholastic Aptitude Test (SAT). However, due to a perceived drop in the predictive validity of the SAT during the 1980s, attention again focused more on the possible identification of non-cognitive prediction measures. The authors collected data from small groups of students enrolled in psychology courses at the State University of New York, College at Genesco, who participated in a 90-minute session to earn optional extra credit towards their grade. Usable protocols were obtained from 201 subjects (157 women and 44 men). Entrance data and cumulative GPA at the end of the semester were obtained from the College Records Office. High school records were unavailable for 14 subjects and SAT scores were unavailable for 20 subjects. Subjects first completed the Jackson Personality Inventory (JPI) and then a 155-item booklet of items with a 5-point Likert format. The two questionnaires yielded four subsets of personality variables (JPI, Big 3, Big 5, and Other).

Correlational analysis of the data indicated that average grade in high school correlated better with GPA ($r = .40$) than did SAT ($r = .34$). Of the personality predictors, 14 were

significantly associated with GPA, with self-control variables having the highest correlation ($r = .38$). Forward multiple regression analyses showed a clear pattern with average grade earned in high school consistently entering first, a self-control variable entering second and SAT entering third. These three predictors accounted for approximately one-third of the variance in GPA. In some analyses, additional variables such as Infrequency, and Attendance were able to account for 2% or 3% of the remaining variance.

Regarding the use of self-control variables in the admission process, the authors expressed a word of caution. They believed that face valid instruments such as those used in their research could be faked. When such instruments were used as part of a selection battery, their predictive strength would thus be less than that shown in the present results. Wolfe and Johnson (1995) concluded by saying that these aspects merited close attention in the admissions process, but they gave no suggestion of how personality could be measured accurately.

The following two groups of researchers followed a different approach in their quest for reliable predictors of academic success. Prus *et al.* (1995) investigated the ability of the Learning and Study Strategies Inventory (LASSI) to predict first-year college academic success. The authors believed that the key to more accurate predictions of student performance in higher education might lie in the ability to assess and understand cognitive and affective processes, including motivation and the strategies with which students study and learn.

The purpose of their study was to specifically determine the extent to which LASSI scores predicted freshman GPAs and retention to the second year, which were two commonly accepted measures of first-year academic performance. The study was also designed to determine whether the LASSI added significantly to the proportion of variance in the GPA and retention that was accounted for by entry-level student variables traditionally available to colleges and universities. The ability to improve on the prediction of other readily available variables was an important measure of the usefulness

of an instrument that was being considered for possible inclusion in any program designed to assess student propensity to succeed.

Participants in the study were 317 first-semester freshmen (48% of the entire class). Students completed the LASSI during class time. The LASSI includes 77 items designed to assess learning and study practices and attitudes. Entry-level student variables included in this study consisted of gender, race, verbal SAT score, mathematics SAT score, and percentile ranks of students in high school graduating classes (as an indicator of prior academic achievement). Cumulative college GPA was assessed at the end of the students' first academic year. Retention was measured on whether or not the students returned for the next academic year. Of the 317 students in the sample, 20% failed to re-enroll at the university the following year. This attrition rate was comparable to the 25% rate observed for the freshman class as a whole.

The results of the research indicated that some LASSI scales demonstrated significant correlations with freshman GPA and retention that equaled or exceeded those between SAT scores and freshman year academic success, but this varied among subgroups in the sample. However, the usefulness of the LASSI in predicting freshman year academic success among college students beyond that which background and entry-level variables could predict was found to be quite limited. It appeared from the results that efforts to predict or explain the large percentage of variance in freshman year academic success unaccounted for by traditional entry-level data would not be aided greatly by the LASSI.

The authors concluded that although a comprehensive measure of motivation might be more helpful in this regard, the individual changes and maturation that tended to occur during the transition from high school to college and during the freshman year in college might defy more accurate prediction of academic success.

Larose and Roy (1995) investigated the Test of Reaction and Adaptation in College (TRAC) as a measure of students' personal dispositions that were likely to affect their adjustment to college teaching style and their academic achievement. The authors

suggested that this measure could also be used by high school and college staff to detect students who were academically at risk as well as for the diagnosing of difficulties in students' personal functioning before they entered college. The administered questionnaire consisted of 50 items that addressed belief, emotional, as well as behavioural factors that intervene in typical college learning situations. The questionnaire was administered to two cohorts of college freshmen in Quebec, Canada – 196 students from urban and 181 students from a rural college. To evaluate the predictive validity of the TRAC, 5 indices related to academic progression (one from high school and four from college) were obtained for both samples during high school and at the end of the first two semesters at college. These were High School Weighted Academic Average (HSWAA), general average (the average of all grades attained by a student during a term), rate of success, students' average of the deviations from the mean for all courses taken during a term, and percentage of course drop-outs and failures.

Most of the TRAC subscales (except the Belief in Effective Work Methods and Belief in Easiness subscales) correlated significantly with HSWAA. In an attempt to predict academic achievement, it was found that the additional variance explained by the TRAC was small partly because of the strong correlation between the HSWAA and the indicators of first-term success. It was found that the predictive capacity of the TRAC was greatly increased when the indicators of second-term success were the predicted variables in the regression analyses. The researchers concluded that the TRAC could be a valuable complement to traditional screening instruments.

(ii) In medical schools

Researchers attempting to predict performance in medical school from non-cognitive characteristics, also reported varying results. Roessler *et al.* (1978) investigated the use of both cognitive and non-cognitive variables in the prediction of preclinical performance.

A total of 116 out of 168 students in the 1974 Baylor College of Medicine entering class and 73 out of 168 students in the 1975 entering class participated. They had all completed a battery of personality tests at the time of their selection interview. Participating students did not differ significantly from their total classes in sex distribution, age, birth order, and ethnicity, or in their undergraduate grade-point average, MCAT, basic science grades, or basic science National Board of Medical Examiners (NBME) scores. Criterion variables were the grades in each of the 10 basic science courses and the mean of those grades, as well as the scores on each of 5 NBME tests and the mean of those scores.

The researchers reported that the addition of personality variables to the usual cognitive variables greatly enhanced the prediction of mean basic science grades and NBME scores. It also enhanced the prediction of individual grades and NBME scores. The results also indicated that basic science grades were predicted more accurately than were NBME scores.

Jones (1990) also investigated the use of non-academic factors to predict academic performance in freshman medical students. The author explained that the homogeneity of medical students' academic abilities often reduced the usefulness of academic measures as predictors of academic performance and that additional prediction measures were thus required. The study was designed to investigate the efficacy of selected academic and non-academic factors in predicting first-term medical school achievement as determined by final examination percentage scores in all Term 1 courses. It was hypothesised that scores on paper-and-pencil measures of anxiety and field independence, in combination with GPAs and entrance test scores, would predict Term 1 grades better than any single academic score or any combination of academic scores.

The subjects for this investigation were 85 of the 96 first year medical students registering in 1988 at the Northeastern Ohio Universities College of Medicine. All entering data were obtained from student files. Anxiety and field independence were measured using the State-Trait Anxiety Inventory (STAI) and the Group Embedded

Figures Test (GEFT) at freshman orientation (pretest) and again at the end of Term 1 (post-test). Dependent variables were percentage scores on the final examination in each Term 1 course, and an overall average of percentage scores in all courses. Term 1 courses were behavioural sciences, human anatomy, microscopic anatomy (histology), molecular pathology (biochemistry), and neurobiology. For each course a student received only one grade, based on the final examination alone.

The academic and non-academic factors were correlated singly with the percentage scores. College GPAs, particularly the science/mathematics GPAs, correlated the highest with Term 1 grades, with correlations ranging from .43 to .66. MCAT scores and high school grades correlated moderately with Term 1 grades. A combination of just two academic factors - the college science GPA and the MCAT Biology scores - accounted for the largest proportion of the variance in first-term grades. The correlations between the nonacademic test scores alone and medical school grades were not significant, either singly or in combination with each other.

The results of this study indicated that combinations of academic factors predicted Term 1 percentage scores better than any single factor, and that combinations of both academic and non-academic factors predicted Term 1 grades better than did single factors and combinations of academic factors. Only in one course out of five did the non-academic factors fail to increase the multiple correlation. A possible criticism of this study is the fact that the sample size was small (85) and consisted only of a single year cohort.

In a prospective study, Green *et al.* (1993b) collected information on the 1988 intake of new students registering for the MBChB course at the University of Wales College of Medicine. A total of 146 (93%) of these students completed a personality questionnaire (Cattell 16 PFQ) on registration. Students' undergraduate record cards were used to obtain factual information on age, sex, A-level grades and undergraduate academic performance up to 2nd MBChB. The students were divided into four groups depending on their academic performance up to and including 2nd MBChB. The majority of students (73%) encountered no major examination problems, but 40 (27%) did

experience such difficulties, nine (6%) of them serious enough to delay graduation. Statistical analyses indicated that academic performance (progress) was not significantly related to any of Cattell's personality factors, either primary or second order. Further analyses of established clusters of factors that had previously been associated with problems among students, were also shown to be unrelated to the medical students' progress. A profile at entry involving previous degrees, points obtained and number of attempts at A-levels proved to be a much better predictor of success during the preclinical period.

A very interesting study was undertaken by Tutton (1996) in order to investigate whether psychometric test results were associated with high achievement in basic science components of a medical curriculum. The study analysed the correlation between scores obtained on the 25 scales and vectors of the California Psychological Inventory (CPI) and academic test results obtained in various subjects by the same students in the first 3 years of the six-year medical curriculum at Monash University, Australia. The study sample consisted of all medical school students at Monash who commenced their medical school education in 1990 or 1991 and who completed the third year of the curriculum in 1993. That means that some dropback students were included in the sample and for those students Tutton used their initial result in the subject (not the repeat result). All the correlations between the CPI results and the examination scores were found to be attenuated by the less-than-complete reliability of each set of data. The correlations between CPI scores and the major types of examination that were statistically most significant were thus corrected for this attenuation. Two sets of correlation matrices were developed with examination results classified firstly by style of examination, and secondly by content of examination (subject matter).

Firstly correlations were developed between CPI results and examination results classified according to style of examination. Results for MCQs, practicals, calculations, and to a lesser extent, essays, were all negatively correlated with some CPI scores that might be considered to be desirable in a caring profession. Tutton reported that they were also, with the exception of calculations, found to be positively correlated with the CPI

vector of Internality. High scores on the Internality vector were usually seen in individuals whose personalities were almost diametrically opposed to what one would hope for in a medical practitioner. Essay and oral examination results were found to be positively correlated with scales such as Socialization, Self-control, and Work Orientation. Results of oral examinations, unlike the results of the other forms of assessment, were positively correlated with the Intellectual Efficiency and Management Potential CPI scales. None of the forms of assessment was positively correlated with the Empathy rating from the CPI, and in fact three of the assessment classes - MCQs, practicals, and calculations - were highly significantly negatively associated with the Empathy scale.

Secondly correlations were developed between CPI results and examination results classified according to content of examination. Results for cell and tissue studies and system units were found to be positively correlated with the CPI Internality vector, and those for cell and tissue studies were actually negatively correlated with several CPI scales, including Empathy. By complete contrast, the scores from clinical and communication skills assessments were positively correlated with many notionally desirable CPI scales, including Empathy, Responsibility, and Tolerance.

A more recent study by Shen and Comrey (1997) supported the results reported by Tutton (1996) despite the fact that this study was undertaken in the USA and thus looked at medical students who had already completed a preclinical programme, whereas the Tutton study was set in Australia where students are accepted into medical school straight from secondary school.

In this previously discussed study, Shen and Comrey (1997:781) were specifically interested to investigate the predictive power of personality characteristics with respect to clinical evaluations. Their study aimed to explore and confirm the relationships among students' cognitive abilities, personality traits and medical school performances. Of the 123 new entrants in 1985 into the UCLA School of Medicine, 97 'not-disadvantaged' students' pre-medical grade point averages ((GPA)s), MCAT scores and personality traits

as measured by the Comrey Personality Scales, were used to predict their clinical performances. The authors explained that disadvantaged students were excluded from the study 'because their poor performances on all criteria would confound the relationships' of personality, cognitive ability, and performance. Academic performance was measured by means of four criterion variables, namely clinical GPA (with ward evaluation as a subcomponent), cognitive score, weighted GPA, and an overall evaluation score.

The results of the analyses indicated that the MCAT score was a strong predictor of medical school performances, particularly for those criteria measured by medical school GPAs and the National Board of Medical Examiners (NBME) examination scores. However, this predictive power dropped sharply when clinical performance and personal suitability were part of the performance evaluation. The authors reported that specific personality traits not only strengthened the predictive power of cognitive and personality variables jointly, but that they became the primary predictors of clinical performance and personal suitability. However, a single personality-profile index failed to show any power of prediction.

Shen and Comrey (1997) concluded that, according to these data, it was not realistic to use one or two personality traits to predict personal suitability on all medical performance measures. The multiple regression analysis results indicated that different personality characteristics were incorporated in different types of medical performances, which was perhaps why the overall personality-profile score failed to predict any of the study's criteria.

(iii) In South Africa

Some South African studies were found which investigated the use of non-cognitive factors as predictors of academic performance. Skuy *et al.* (1996) explained that in South Africa the matriculation examination results had in the past been accepted as the best

readily available predictor of success at universities and had as such presented the major criterion for acceptance. However, as black South Africans had been subjected to significant educational disadvantage, their matriculation results could not be taken as a true reflection of their academic potential. The exclusive use of school marks as admission criteria could therefore lead to an unjustifiable exclusion of a significant proportion of black students from university admission. The authors believed that the use of multiple methods of identification would increase the chances of accurate selection. They further stated that such concepts as self-motivation, characteristic approaches to tasks, and the nature of the material to be learnt would enhance predictive validity of selection criteria and thus needed to be taken into account. Skuy *et al.* (1996) therefore conducted a study aimed at exploring the relative value of various predictors for disadvantaged versus advantaged students.

The study subjects comprised 26 students enrolled in the Pre-University Bursary Scheme (PBS) at the University of the Witwatersrand in 1991. This was a bridging year provided for students who fell just below the academic criterion for acceptance into the Commerce Faculty's programmes of study (for example B Com). Eighteen of these students were from educationally disadvantaged backgrounds, in other words students who had received their secondary school education under the aegis of the Department of Education and Training (DET). Two sets of predictor variables were used; namely, a battery of static (conventional/ psychometric) tests to assess current levels of functioning in the areas of intelligence, academic performance and motivation, as well as a battery of process tests which made use of a learning-oriented approach to testing and assessed the cognitive processes involved in various task performances. This battery included a dynamic (teach-test-teach) measure. The predictor measures were administered to the subjects on two full mornings of testing near the beginning of the academic year. The subjects received the battery of static tests in Session One and the battery of process tests in Session Two. All tests were administered in a group. During the second semester, each student was interviewed on a one-to-one basis, using the Interview Measure (IM). Independent and qualified raters, who were not connected with either the study or the PBS, and were thus not acquainted with the students, carried out scoring of the various

measures. The criterion variables were the results of the mid-year university examinations in Accounting, Mathematics, Statistics, and Business Studies.

The results of this study were most interesting. The authors admitted that the small sample size (26 students) had a limiting effect on the conclusions that could be drawn and also precluded the possibility of a regression analysis which would have provided information regarding the relative weighting of the different significant predictors of academic performance. The most noteworthy result was the lack of predictability of the academic success of the 18 disadvantaged students in this study. Although the matriculation results did not relate significantly to success for either of the two groups, for the much smaller advantaged group (8 students), a number of highly significant correlations were found between academic success and the predictor variables. Most of the static and process-oriented measures produced moderate to high correlations with the performance of the advantaged students, but there were hardly any significant or near-significant correlations between academic success and the predictor measures for the disadvantaged group.

The authors concluded that the result of their study was commensurate with other researchers who were becoming increasingly dissatisfied with traditional psychological measures as accurate assessors of academic potential and success for disadvantaged students. This researcher had observed that serious questions have been raised regarding the validity of widely used psychological tests and conventional definitions/criteria of intelligence/cognitive ability. The issue of relevant selection procedures for South Africa that will hold for all groups, i.e. from socio-politically advantaged and disadvantaged communities, has become increasingly pressing in this country.

In a study at the Cape Town Technikon, Louw *et al.* (1998) aimed at developing statistical models for the prediction of a prospective Environmental Health students' chances of being successful in their academic studies, both at first-year and at third-year levels. The study sample consisted of all students who were first year Environmental Health students at the institution in 1989 – 1995, as well as all those students who were

third years in the same department in 1991 – 1995. Each group was randomly divided into two to enable validation of the results. Multiple regression analyses were developed to predict academic performance. Apart from using school results as an indication of previous academic performance, measuring instruments included a number of cognitive as well as non-cognitive measures such as interest, personality, learning style, motivation, and academic self-esteem.

The results of this study showed overwhelmingly that matric results were the best predictor of academic success both in the first and in the third year of Environmental Health studies. Matric grade point average (average of all 6 matric subjects) was by far the strongest predictor both in the multiple regression equations and in the factor analyses. None of the non-cognitive measures played a significant role in the prediction of either first year or third year performance.

3.2.12.1.3 CONCLUSIONS

Although much had been written about, and much could possibly be gained by the use of non-cognitive variables as predictors of tertiary academic performance, the literature review did not paint a positive picture in this regard. It appeared as though a higher proportion of the variance in first-year academic performance could be predicted if non-cognitive variables were added to cognitive variables in multiple regression analyses. However, individual non-cognitive variables tended to have a low relationship with first-year academic performance.

The use of psychometric test results as selection tools appeared to be particularly questionable. Not only was it very expensive to test large numbers of applicants, but very often it appeared as though researchers and/or heads of department simply put students through a batch of available tests without knowing whether the results would be useful or not. Questions need to be asked about the justifiability of the expense, which

very often has to be borne by the student who not only has to pay to take the tests, but also has to travel to the institution at his/her own expense.

Some very serious concerns emerged around the use of self-reporting questionnaires as part of the selection process. It was stressed in the literature that it was possible to fake face valid instruments. Once students were therefore aware that results of such tests would be used for screening purposes, they might give the answers that they expect were required of them. This would obviously immediately lower the predictive strength of the instrument.

Concern was also raised in connection with the maturity levels of young school leavers. It was argued that it could be rash to base a career on a personality profile obtained from teenagers.

No recent studies could be found on this topic and up to the latest studies reviewed no clear trend emerged which could point towards the use of some of these characteristics as predictors of tertiary academic performance. Another seriously compounding factor was also the fact that even those non-cognitive characteristics that could be shown to have some predictive value for advantaged students appeared to have no (or very little) correlation with the tertiary results of black students.

3.2.1.2.2 PREDICTION OF ACADEMIC OUTCOME FROM PRE-REGISTRATION CHARACTERISTICS

As discussed in the previous section, the structured research on predictions from pre-registration characteristics was most often an attempt to predict future quality grade point averages. This type of research relied mostly on regression analyses to identify those variables that correlated with the final course grade. However, the problem that concerned the tertiary institutions was not necessarily the knowledge of what scores prospective students could be expected to earn in their tertiary studies, but the problem of

student attrition and the development of retention strategies. As early as 1971, Blanchfield (1971) suggested that the use of regression analysis to try and predict the future grades of entering freshmen was futile. He made a case for the use of discriminant analysis for the purpose of identifying potentially successful or dropout students rather than just ranking students on a scale (Blanchfield 1971).

It is important to note that two different types of student behaviours exist, namely academic performance and persistence in tertiary studies. Some degree of independence appears to exist between academic success and persistence because some students who were successful academically do not persist while other students who persist in their tertiary studies are not successful academically.

Most of the published research in this field of research came from the USA. Although every study reviewed must be seen as an important attempt to find those pre-enrollment characteristics that would identify the student that would have a poor academic performance, results from these studies were almost impossible to compare. Most researchers used their own unique method of categorizing students at risk of academic failure and various statistical methods were used to try and identify possible predictors of student persistence.

In defining criterion categories for studies of tertiary attrition, it could be useful to distinguish between academic dismissals that are required to leave because of poor academic performance, those who are academically at risk but who still persist in the institution (dropbacks), and withdrawals who leave voluntarily. However, a serious problem observed from the published studies was the fact that so few authors differentiated between the different types of attrition and simply tried to distinguish between students who were successful and students who were not. This finding was consistent with the conclusion drawn by Peers and Johnston (1994) in their meta-analytic review of twenty published studies spanning a period of forty years. Many studies looked at end-point results only, either degree status or average scores of final examinations (Final GPA) (Scannell 1960; Lazin & Neumann 1991; Green *et al.* 1993a;

Todd & Raubenheimer 1994). Very few researchers (Lazin & Neumann 1991; Green *et al.* 1993a; Green *et al.* 1993b) mentioned dropbacks (delayed graduation), with the majority simply including them under “failures” (Danko *et al.* 1992; Cariaga-Lo *et al.* 1997; Huff & Fang 1999). This fact was surprising, as dropback students should be as important as failures from an institutional viewpoint as they use up valuable resources in repeating a year or in receiving support services.

Campbell and Dickson (1996:48) stated that ‘... *although the literature is replete with achievement studies, no consistently stable predictor variables have been identified*’. This statement appears to be incorrect when seen in the light of the studies reviewed in this thesis. The results reported in these studies mostly indicated that previous academic performance was a good predictor of later success (Scannell 1960; Bean & Covert 1973; Ott 1988; Danko *et al.* 1992; Bokhorst *et al.* 1992; Green *et al.* 1993a; Green *et al.* 1993b; Levin *et al.* 1994; Todd & Raubenheimer 1994; Jawitz 1995; Simpson & Budd 1996; Cariaga-Lo *et al.* 1997; Huff & Fang 1999). However, even though cognitive variables emerged as stable predictors of later success, it became apparent that a substantial part of the variation in students’ academic performance at a tertiary institution was still unpredictable from the evidence available at the time of registration.

Only a few studies mentioned non-cognitive characteristics as indicative of later success (Jackson 1955; Lazin & Neumann 1991; Scholtz 1991). Some authors actually came to the conclusion that personality factors and other non-intellectual factors yielded inconsistent findings and should not be included in selection procedures (Green *et al.* 1993b; Todd & Raubenheimer 1994; Campbell & Dickson 1996).

3.2.1.2.3 CONCLUSIONS

A large number of researchers attempted to find those characteristics in applicants to tertiary studies that would best indicate to the selector which students to enroll into the different programmes. Studies attempting to predict future academic performance as well

as those that tried to predict success or failure were reviewed. Only cognitive pre-registration characteristics emerged as stable pre-registration variables for the prediction of both academic performance and successful completion of the first year of tertiary studies. Particularly school results appeared to have some value in the selection process although a substantial part of the variation in students' academic performance at a tertiary institution remained unpredictable from the evidence available at the time of registration.

It was found that this situation was even more complex for students from disadvantaged academic backgrounds as their academic performance and attrition were very difficult to predict from data available at the time of registration.

Great expectations have been built around the use of non-cognitive variables as predictors of tertiary academic performance and success of students. However, a scrutiny of the available literature painted a less than optimistic picture as no clear trend emerged which could point towards the use of some of these non-cognitive characteristics in the selection process. Another seriously compounding factor was also the fact that even those non-cognitive characteristics that could be shown to have some predictive value for advantaged students appeared to have no correlation with the tertiary results of black students.

Against this not very optimistic picture which showed just how difficult it is to select the "correct" cohort of freshmen from a large group of applicants, one has to consider the present situation in South African tertiary institutions.

3.2.1.3 SELECTION IN THE SOUTH AFRICAN CONTEXT

Experience has shown that student selection rates together with student retention rates are coming more and more under the spotlight in South Africa. Whilst making a strong case for the development of a selection policy by all institutions/departments which would

clearly define the characteristics required in future students, and which would also clearly indicate the tools to be used to measure such characteristics, Powis (1994) also acknowledged the difficulties around the implementation of such a policy. She mentioned the fact that many institutions often did not use the appropriate methods for the identification of the required characteristics because such methods were costly and time-consuming to use. Even more importantly, she stated that, even if such identification methods were in place and being used, very often medical schools (and other institutions) were subjected to pressures or other outside influences that sought to modify the selection process. (Powis 1994.)

In South Africa, such "outside" influences are particularly strong. Within the reality of an ethnically defined demography and a history of unequal provision in education, tertiary institutions cannot only select those students who have a fair chance of successful completion of their studies. Institutions should also work towards a selection policy that will ensure equity as far as the different population groups are concerned. This would allow a distribution of the resources available to education across a wider spectrum of population groups and in a more equitable manner.

Huysamen (1996) explained that a number of conflicting demands existed that would all exert an influence on the issue of admissions to tertiary educational institutions in post-apartheid South Africa. When considered in isolation, none of these demands appeared to be totally unsolvable, but their simultaneous solution seems to require a fair degree of compromise. Mehl (1992) identified eight such conflicting demands. These are:

- * the limited public funds available for higher education
- * the unequal access afforded to different population groups
- * the culture of entitlement among such groups
- * the unpreparedness of such groups for tertiary education with a resultant restriction in their choice of curricula
- * the lack of a quick fix for these problems

- * the inflexibility of the South African educational system
- * the reigning culture of non-accountability
- * marked differences between different institutions of higher education.

It seemed as though the problems of restricted public funds and the disproportional representation of different demographic groups were not unique to South Africa as they also appeared to exist in other developing countries around the world such as China, the Philippines, and Indonesia (Klitgaard 1986). However, any attempt to redress imbalances of the past by means of fair and unbiased admissions procedures as set against the combined realities of access and equity must make the extent of the problem fairly unique to South Africa (Huysamen 1996).

Several South African researchers (Griesel 1992; Miller 1992; Parsons 1993; Huysamen 1996; Skuy *et al.* 1996; Zaaiman *et al.* 1998; Dawes *et al.* 1999; Huysamen 1999; Huysamen & Raubenheimer 1999) argued that the history of separate education departments for different population groups had ill-prepared applicants from especially the (black) Department of Education and Training (DET) for tertiary studies. As a result, applicants from this department were at a disadvantage when they had to compete for admission to tertiary institutions with candidates from other race groups. The groups for whom greater access to tertiary education was sought, were thus the very groups who had been exposed (and no doubt will be exposed for some time to come) to an inferior high school education.

The increasing numbers of students seeking admission to South African tertiary institutions thus seemed to present an enormous challenge. Projections made by File (1986) indicated that the number of white matriculation passes (with exemption) would decrease from 27 600 to 25 500 between 1990 and 2000. For the same period, however, the number of black matriculation passes would more than double (from 15 000 to 32 000) and the overall effect would thus be an increase of 36.8%. This increase would necessitate relevant efficient and fair selection procedures at South African tertiary institutions.

It was argued that insufficient financial resources to subsidize, for long periods of time, tertiary education students who had little or no chance of academic success, compounded this situation even further. In an excellent article Gourley (1992) addressed financial management issues in South African universities in the early 1990's. It has since been observed that all the issues mentioned in this article have only become more serious and the precarious financial situation of South African universities (and technikons) presents very real problems in the present political and socio-economic climate in this country. Melck (1999) recently indicated that the reduced public funding per student had a serious effect on access to universities and that tertiary institutions were experiencing 'an imbalance between what they could offer and what was required by the market'. Gourley (1992) stressed the fact that good financial management had never been more important in universities. There were clear indications that with the hardening of the economic recession, and with government coming under pressure from all quarters, university funding was inevitably diminished and financial management became critical. It was stressed that financial management had to be seen in its totality and dealing with long-term risk and liquidity assessment, with financial planning, and with strategic decisions that focus on ensuring the survival of the enterprise. Gourley (1992) argued that one of the important decisions that had to be taken by an institution's managers was what student mix the institution could actually sustain. She stated that black students, through no fault of their own, came from a schooling system that had in no way prepared them for tertiary studies. These students would need support and it was up to the institution to decide before admitting such underprepared students whether they could support them or not. The institution had to thus take a strategic decision on whether they would support those students, or whether their selection methods should deliberately avoid students who would cost the institution much in resources and time (Gourley 1992).

This economic consideration makes an egalitarian position, in terms of which all that are interested in pursuing a tertiary educational career should be granted an equal opportunity of being admitted, untenable (Huysamen 1996). Brezinka (1985) also commented on the deceptiveness of the democratic principle of equal opportunities in higher education. He stated that even if every applicant was admitted to the institution of higher learning of his

choice, there was no guarantee that every graduate would find an employment opportunity commensurate with his or her training. Apart from these considerations, there was also the emotional trauma of those students who, through no fault of their own and despite hard work, simply were incapable of academic success at tertiary level (Huysamen 1996).

As mentioned before these “outside” pressures and influences that seek to modify the student selection process at tertiary institutions are particularly strong in South Africa. This makes the student selection process in South Africa even more problematical than in most other countries.

A survey of the available literature on admission policies in Southern Africa indicated that although not many studies explicitly stated admissions requirements, matric results were apparently the criterion used most frequently. The matric results were used mostly in the form of point value scored or as the grade point average (Bokhorst *et al.* 1992; Ayaya 1996; Louw *et al.* 1998), and the scores obtained in specific matric subjects were also often used in the selection process (Bokhorst *et al.* 1992; Jawitz 1995; Ayaya 1996; Bargate 1999).

Personal experience has taught that such a single criterion approach to admission into tertiary studies is unacceptable. Too many applicants with outstanding personal qualities and achievements will as a consequence be excluded from higher education. At the same time such an approach will also prevent the widening of access to previously disadvantaged students.

Whilst many more black students from previously disadvantaged educational backgrounds must be allowed admission into tertiary studies, most South African studies reported that the selection of disadvantaged students was fraught with problems and of serious concern. The issue of relevant selection procedures for South Africa which will hold for all groups, has thus become increasingly pressing (Skuy *et al.* 1996; Zaaïman *et al.* 1998). Huysamen (1996:200) stressed the fact that the problem of disproportional

representation at tertiary institutions could not be solved 'in isolation of the poor quality of teaching at some high schools and attempts to provide academic support programmes to deserving students'. It unfortunately appeared as though poor teaching was likely to continue at some schools in the near future. With the problems apparently occurring in the South African school system and made common knowledge in the press, this situation of underpreparedness for tertiary studies might become even more serious over the next few years. Even if deserving students were put into support or development programmes, such students would still have to be sifted and selected in order to separate out those who would benefit from such a programme and be able to continue with tertiary studies. Many South African studies emanating from institutions that select students into a development/ pre-institutional support programme, unfortunately did not indicate on what basis they made their selection decisions (Colborn *et al.* 1993; Venter 1995).

The latest available studies on the topic of selection in the South African context (Zaaiman *et al.* 1998; Dawes *et al.* 1999; Botha & Cilliers 1999; Huysamen 1999; Huysamen & Raubenheimer 1999) showed that the search for a solution to this problem is ongoing and intense.

3.2.1.4 CONCLUSIONS

As was explained before, the theoretical models of attrition (Figures 1 to 4) indicate that it might be possible to manage attrition at two interception points, i.e. firstly from pre-registration data, and secondly in the post-registration phase. Of these two possible intervention phases it would undoubtedly be better to utilize the information available at the time of registration to select the "correct" cohort of students for an academic programme.

However, a review of the literature indicated a very clear but not a very optimistic picture. It was evident that despite the huge body of research devoted to the pre-registration period, attrition rates around the world were unacceptably high, which

indicated that the often very costly and resource intensive selection policies and methods in use around the world were still not be able to select students effectively and efficiently.

The literature did indicate that it was relatively easy to select the “good” or potentially successful student, as a reasonable correlation was demonstrated between previous academic performance and tertiary academic performance. This correlation, however, became less obvious for the lower performing students and was weak for disadvantaged and particularly for black students.

Tertiary institutions should also select into programmes, particularly into the health-related programmes such as medicine and chiropractic and homoeopathy, students with particular personal characteristics that would make them “good” doctors. This fact thus further compounds the difficulties around student selection. Unfortunately no non-cognitive variables emerged in the literature available that could be directly linked to freshman success.

In addition to the above considerations, student selection should also be relevant and fair and tertiary institutions should also rapidly broaden their access to previously disadvantaged applicants. In South Africa the previously disadvantaged students are mostly black and published studies indicated that for those students tertiary success was almost impossible to predict from pre-registration characteristics.

In the light of the above situation the question was asked to what extent it would be possible to use the pre-registration characteristics for the management of attrition. Should institutions not look for sizeable reduction in attrition rates to the next phase of management intervention, which is the post-registration phase?

3.2.2 MANAGEMENT OF ATTRITION: THE POST-REGISTRATION PERIOD

Phase two in the management of attrition, the post-registration period, is very important to both the student (particularly the first-year student) and the institution. Whatever the method used to select students, high attrition rates around the world indicate that large numbers of students and particularly first-year students, discontinue their studies before completion of the programme they enrolled for.

From the literature review it became apparent that a substantial part of the variation in students' academic performance at a tertiary institution was unpredictable from the evidence available at the time of registration. This situation was even more complex for students from disadvantaged backgrounds as their academic performance and attrition rates were very difficult to predict from pre-registration data. Although all institutions will have to employ some form of selection in their admissions procedure, it appeared as though all potential dropouts could not be identified and therefore eliminated before registration. It might thus be that the post-registration period might be the most important in the management of attrition.

The theoretical models of attrition (Spady 1970; Tinto 1975; Tinto 1997; Johnson & Buck 1995) (Figures 1 to 4) implicated academic performance after the student arrives on campus as the major cause of attrition.

Van Overwalle (1989) explored and compared the impact of several social, personal, and educational factors influencing achievement in the first year at a Belgian university, and found support for the statement that real effects on attrition rates could only be achieved after registration. From the results of this study the author concluded that factors inside the educational context, in that case the university, had the strongest impact on the academic outcome of the students who participated in his study. He found, *inter alia*, that study-focused social help and support as well as ability in academic matters were

very important in determining the academic success of freshmen. In contrast he reported that factors outside the immediate academic environment, such as leisure time activities or socio-economic background, had little impact on educational attainment.

Terenzini and Pascarella (1977) also suggested that sizeable reductions in attrition might be possible only through actions that touched both the social and academic dimensions of the institutional environment. In a subsequent paper (Terenzini & Pascarella 1978), the same two authors assessed the relative influence on attrition of students' pre-college characteristics, their experiences and perceptions of the freshman year and the interactions of gender, subject major, and racial or ethnic origin with those experiences and perceptions. A series of stepwise multiple regression analyses indicated that pre-college traits were not significantly related to attrition and that integration in the academic systems of the institution might be more important than involvement in the social systems, and that certain interactions between pre-college traits and freshman year experiences and perceptions might be the most important. Their findings suggested that attrition reduction efforts might need to be focused on what happens to students after they arrived on campus, on academic areas, and perhaps on the development of selective plans designed for different kinds of students. This statement was reiterated in a later paper (Pascarella & Terenzini 1983) concluding that academic integration could only be measured once a student had been assessed at the tertiary institution.

Blustein *et al.* (1986) supported the statement by Terenzini and Pascarella (1979) that integration in the academic systems of the institution might be more important than involvement in the social systems. Using interview and survey data, the authors identified two major variables (cognitive ability and student expectations) as predictors of grade point average in a community college population. They reported that the academic integration variable maintained its prominence as the primary predictor of academic success in a community college setting. Although there was no empirical measure of social integration, a review of the interview protocols revealed that academic factors were far more significant than social integration in defining a student's sense of involvement with the institution. Blustein *et al.* (1986) concluded that it was also necessary for

counselors and administrators to recognize that students who were in academic difficulty had a delineated set of attitudes regarding their expectations of learning that required the attention of student development professionals and thus the development of specific support programmes. It was thus very important that these students be identified early, before this mind-set developed or was strengthened by their failure.

Management of attrition in this post-registration phase should therefore be concentrated on the early identification of the student at risk of failure and the provision of specific remedial/support services to such at risk students particularly during the freshman year.

3.2.2.1 STUDENT SUPPORT PROGRAMMES

In an attempt to solve the problem of high attrition rates, tertiary institutions appear to be increasingly paying attention to student support programmes. Ferreira (1995) explained that academic support programmes were generally considered as interim strategies to bridge the gap between inadequate schooling and tertiary education. One would question such a singular approach to student support, particularly in the light of the seriousness with which medical schools and other professional schools in America (McGlinn & Jackson 1989; Segal *et al.* 1999; Taylor & Rust 1999) view support programmes. It must be remembered that these students all completed pre-professional tertiary programmes before being selected into the professional schools and 'inadequate schooling' could therefore not be blamed for unacceptably high attrition rates. In the South African context, however, Ferreira's (1995) statement is very applicable. Large numbers of underprepared students are entering tertiary education, but are also failing in large numbers. In planning academic development in South African tertiary institutions, these underprepared students should therefore be an important target group (although not exclusively so) and any support programme must be able to prove its effectiveness in terms of these students (Koch & Mallon 1998).

A scrutiny of the literature indicated that factors other than academic ability might also contribute to student attrition. The failure of many students might therefore not necessarily or exclusively occur because of lack of academic ability. If non-academic factors could also result in less than adequate academic performance, one needs to question whether modified institutional practices or policies might remedy this waste of talent or ability. Post-registration student support can take on many forms, for example by providing assistance during the student's undergraduate studies by means of support programmes, or by changing university curricula in accordance with the student's preparedness level. The latter option would, for example, result in a student registering for fewer subjects than the norm (Ferreira 1995).

A number of American authors reported on support programmes aimed at the early identification, remedial plans, and appropriate accommodations for at-risk students in undergraduate colleges as well as professional schools. The support programmes were taken very seriously by medical schools (McGlinn & Jackson 1989; Segal *et al.* 1999; Taylor & Rust 1999). Particularly the nurturing of students from the underrepresented minority groups and attempting to ensure that their academic performances were comparable to those of the other students were taken seriously by the medical schools. However, Taylor and Rust (1999) reported that despite these support programmes the most recent complete data for medical students in the USA indicated that whereas 85% of the non-minority students graduated with their class in 1996, only 61% of the underrepresented minority students did. The authors concluded that it was clear that these students had needs that went beyond what their medical schools were actually providing. Other researchers around the world also found that disadvantaged students required more guidance and support in their tertiary studies (Guri-Rozenblit 1990; Segal *et al.* 1999). Giliberti (1998) felt so strongly about the fact that minority students performed so poorly when compared to other students, that he made a firm proposal that support programmes should be mandatory for all minority group students.

Taylor and Rust (1999) further explained that learning involved a psychosocial relationship between the teacher, the student, and the educational setting. The purpose of

learning was to prepare the student to cope in new settings and to create a desire for life-long learning. They stressed the fact that in order to ensure academic success, medical schools had to be able to accommodate diverse learners of more than one learning style. They suggested that academic success for learners from different ethnic and cultural groups could be nurtured through a supportive learning environment, teaching that was successful with all styles, and by valuing students' diverse cultural identities.

Segal *et al.* (1999) explained that at the University of Michigan Medical School, the support programme started with a referral made by the student, an academic counselor, or a faculty member. To be referred, a student had to be seen as being academically at risk. Students were automatically referred if they were on academic warning or were seen to be in danger of academic warning. They explained that the ultimate aim of the support programme was early intervention, in other words to identify students who were academically at risk before they experienced serious academic failures. The authors explained that the evaluation that took place after referral consisted of an intensive semi-structured interview with a clinical psychologist, the completion of behavioural screening checklists, and mostly academic achievement testing. According to the authors the purpose for this 'psychological/academic triage' was to obtain background information on which to base appropriate recommendations for intervention or accommodations. Students could be referred to the academic units for specific types of academic support, which could include tutors, assistance with study skills or even accommodations in the classroom such as extended time on examinations and assistance with note-taking. Segal *et al.* (1999) further reported that, during the first four years of the support programme at their medical school, 28 medical students were identified through it and 24 of these students (86%) were from the underrepresented minorities group. Most of these students were referred either during their first or third years of study and, after a variety of support services, 26 of these students (93%) either graduated or continued to progress in medical school.

Unfortunately results from American medical schools such as the Segal *et al.* (1999) study discussed above, could not be directly applied to or compared with those from

South Africa. It must be remembered that medical schools in the USA only take in students who already completed their pre-clinical studies. The medical students are therefore (usually) much older than the South African recent matriculants and have already proven that they can cope in tertiary studies. Two facts from this study were, however, important to note. Firstly, Segal *et al.* (1999) also found that it was mostly underrepresented minority students who had academic problems and secondly, they found that intervention methods applied timeously could save most of these students from attrition. This last finding agrees with that of other researchers who reported that support contributes to perseverance (Guri-Rozenblit 1990).

It is very tempting to devolve the blame for student attrition on the selection process. However, as was seen from the above study, as well as from other papers such as the one by Simpson and Budd (1996), evidence existed that if students were supported during their time at medical school (or in other tertiary studies), some academic problems could be reduced or even avoided. It is important that institutions are aware of their responsibilities in this regard and also that the institutional commitment to student support exists. Simpson and Budd (1996) also agreed with Segal *et al.* (1999) in that student support should be provided in different forms to suit the needs of different individuals. They believed that greater attention should be paid to helping students deal with stress and to recognizing those with mental problems. They also felt very strongly that students should be encouraged to develop good study habits early in the course. This last statement was found to concur with the work done in the medical school at the University of Tromsø. Martenson and Brattenbo (1992) reported some educational development activities undertaken to try to reduce failure rates. The medical programme at the University of Tromsø has a community-oriented curriculum of six years duration with students selected straight from school. Some of the procedures that were introduced were teacher training, and the introduction of small-scale experiments that introduced active teaching methods. A recent development was the introduction of a 2-day pedagogical weekend course for all first-year students. The main aim of the course was to help the first-year students 'survive' academically. The course content covered study approaches and study skills, learning issues, and preparation for the first comprehensive

examination. Unfortunately the authors did not evaluate whether the weekend course had a positive outcome on the attrition rate. What was important, though, was the emphasis placed by the Tromsø medical school on teaching and learning in the attempt to diminish attrition. Very few other institutions were found that addressed teacher training and methods of teaching in this regard despite early calls by some researchers such as Baumgart and Johnstone (1977) that teaching and learning strategies had to be addressed as they believed that most of the currently used methods were outdated. They also suggested that students should be allowed to proceed at different rates and carry different workloads.

A number of studies on student support programmes emanated from South Africa. As a first step in developing a support programme at Potchefstroom University for Christian Higher Education (PU for CHE), Scholtz (1991) designed a study whereby psychometric test results were used within the first two weeks after registration to identify first-year students who were at risk. The author reported that all first-year students at PU for CHE routinely completed a battery of psychometric tests during their first week on campus. Only first-time full-time students registering in 1984 were selected for the initial study and, on the basis of their performance in the first year examinations, the students were divided into two groups. The first group of successful students (N=479) consisted of students who obtained 90 or more credits during their first year and who would be able to complete their degree within the prescribed period. On the other hand, the unsuccessful group (N=184) were students who obtained 60 or less credits and who were seen as at risk and would not be able to complete their degree within the minimum time period. The group with 61-89 credits was omitted from the study in order to be able to better distinguish between the successful and unsuccessful students.

Statistical analyses indicated that the psychometric test scores discriminated well between the academically successful and academically at-risk students and the study was repeated on the 1985 intake of new first-year students with exactly the same results. The decision was then taken to use this finding in a preventative manner and discriminant analysis was applied immediately to the psychometric results of the 1987 first-year students. On the

basis of these results a total of 172 possibly at-risk students were identified from a global 843 first-year students. These 172 first-year students were divided into their faculties and then a random decision was taken to start with the Arts and Science faculties. A total of 18 students each from these two faculties was randomly selected to take part in the experiment. The students were then divided into equal groups to act as experimental and control groups.

A support programme was designed for these at risk students. The programme included an interview where the student could discuss his/her choice of career, a study methods course, a reading improvement course, as well as group therapy. Scholtz (1991) reported encouraging results from this support programme. Whereas the control group performed as was expected of them, in other words globally below 60 credit points, the experimental group performed globally above 90 credits points. The experimental group thus performed well enough to move to the “successful” group, whilst the control group performed, as predicted, in the “unsuccessful” group. The difference between the performance of the two groups was found to be statistically significant.

This apparently good result reported by Scholtz (1991) would need to be further investigated and repeated with a larger group, as well as with students from other faculties. Eighteen students are not enough to draw firm conclusions from. Unfortunately no follow-up study to this early research by Scholz (1991) could be found in the literature.

Grobler (1994) explained that the background to his two studies (Grobler 1993; 1994) was the problem of still providing quality teaching whilst having to cope with large numbers of students, some of whom being academically and culturally disadvantaged. The researcher wanted to investigate whether one lecturer could ensure academic stimulation for the good students whilst weaker students were given extra support. Grobler (1993) developed a differentiated teaching model after an investigation of a group of first-year Physiological Psychology students. Of the 365 students in the introductory course, 165 volunteered to take part in the experiment. The students were divided into three groups on the basis of their scores in the first class test. The good

students (achieving 75% and higher) were given additional reading work as stimulation, whilst the weaker students (< 60%) were seen as an at-risk group and received supportive material. The students in this high-risk group were divided into groups of fewer than ten each and met at least once a week under the leadership of a senior student to discuss their experimental assignments. The middle group (60-74%) served as a control group in order to see whether the fact that a student took part in such an experiment alone would improve his performance. The control group discussed general problems that students had to deal with, but no academic matters. The remaining 205 students who did not take part in the experiment were also divided into three similar groups on the basis of their first test results. They received no extra attention, but their results at the end of the semester were compared with those of the first three groups.

The author reported that the results of this study indicated that the group of high-risk students benefited greatly from the intervention and a proposed model of differentiated learning was then developed. The author claimed that this model could enable one lecturer to accommodate the 'emotional and academic needs of a large group of students, who may differ in terms of cultural and intellectual background, within one class group'.

In a subsequent study (Grobler 1994) the author attempted to determine the extent to which differentiated education could improve learning in relatively large groups of students (350-400). Participation in the programme was completely voluntary and available to all students who registered for Physiological Psychology at the University of the Orange Free State during the second semester of 1991. The students were invited to participate in an experiment that would take place over 4 weeks between the first and second class tests. All students who participated would be given 3 extra points on the DP (year mark)

The author reported that during the previous year (1990) results obtained in the first test appeared to be good predictors of success at the end of the course. As students were not able to obtain past test papers, the same test was administered to the test group in 1991. As in the previously discussed study (Grobler 1993) students were divided into three groups on the basis of their performance in this test. Group 1 were those who obtained

75% or more, Group 2 those who obtained between 60-74%, and Group 3 those who obtained less than 60%. Each group was again divided into two groups, those who wanted to participate and those who did not want to participate. Group 2 again received reading material that had nothing to do with the subject but which dealt with general problems experienced by young people. This was to try and determine whether the placebo effect, in other words the mere fact of participating in such a programme, would have a positive effect on the test results. Group 3, who could on the basis of previous groups of students be seen as a risk group, received a complete explanation of the work on audiotapes, explanatory reading material, as well as videos. The aim was to help this group to understand the work better. Small groups of students (10 or fewer) in each group also met regularly with tutors.

The author reported that the efficiency with which the first class test could predict eventual academic success was demonstrated by the fact that 41 of the 59 distinctions came from Group One. Only one student from this group needed a supplementary examination and no student from this group failed the course. The results of this group of students decreased in test two. Some possible reasons for this occurrence were put forward, such as over-confidence after the first good results, or the difficulty of maintaining good results. These students might also not have been doing much of the extra work expected of them as no possible credit was tied to it. The results of the Group 2 students stayed amazingly constant, which the author suggested, might be an indication that the placebo effect did not have a role to play.

Despite this statement by the author, the publication indicated that the results of Group 1 decreased, so the mere fact that the Group 2 results stayed the same might be an indication of an improvement in the group and that the placebo effect perhaps did have an effect on their result. Perhaps the material dealing with general student problems did have a positive effect, as the author reported that all the students from Group 2 who participated in the experiment passed the subject whilst from the Group 2 students who did not participate, 2 students withdrew and 5 failed. So, although the experimental procedure did not help Group 2 to improve their results, it might have helped them to maintain their results throughout the semester.

The fact that the Group 2 students all passed, despite not having actually improved their results, should perhaps be viewed as one of the most important outcomes of the Grobler (1993) study. Improvement in actual test results might not be the most important factor under investigation. Success or failure at the end of the year must be seen as the ultimate aim of any support programme. It might thus have been that the extra attention Group 2 received (the placebo effect) did, in fact, help them to maintain their focus and stay committed to the goal of graduation. This possibility could have far-reaching implications for support programmes.

According to Grobler (1994), it appeared as though the experimental procedure did have a significant and positive effect on students at risk of failing. The Group 3 students who did not take the opportunity of participating in the experiment had a lower mean in the first test than those Group 3 students who elected to participate. The results of the second test showed a significant improvement in the results of the experimental Group 3. However, so also did the results of the non-experimental Group 3 improve. Of note is the fact that, although the supportive work only covered the four weeks between test 1 and test 2, the experimental Group 3 still showed a very positive effect on their final result. Less than half of the non-experimental Group 3 were successful, whilst 86.6% of the experimental Group 3 passed at the end of the year. Also from the experimental Group 3 only 1 student out of 60 was not allowed to sit for the examination, whilst 23 out of 84 in the non-experimental Group 3 did not obtain a sufficiently high year mark to qualify for the final examination.

The author concluded that effective implementation of the proposed model of differentiated teaching could be very useful in the current South African context as it would allow a lecturer to handle large numbers of students with widely differing backgrounds, all in one class. The author did caution, however, that such a method would initially require a large input from the lecturer. One would assume, also, that a fair bit of staff development would be needed in order to empower lecturers for this very important task.

Parsons (1993) approached student support from the perspective of approaches to learning, i.e. 'deep' and 'surface' approaches. As background to his study he explained that research into student learning had indicated that the ways by which students approached studying were not fixed attributes that could not change with changing educational contexts. It appeared as though some modifiability existed in these approaches. However, consistency in approach appeared to exist when no intervention took place, whereas in an academic climate that supported and encouraged change, some students appeared able to modify their study orchestrations or to undergo change. Parsons (1993) thus posited that an intervention programme could be devised that would seek to alter the 'impoverished qualitative perceptions of the learning context and the associated disintegrated theoretically desirable approach to studying'.

In order to test this hypothesis, students who were identified as being possible at risk students (those who manifested a disintegrated meaning orchestration which both theoretically and empirically was associated with academic failure), and who obtained less than 50% on the first class test, were invited to attend five sessions run jointly by the counselor and the subject teachers concerned. Students not categorized as at risk who asked to participate were also allowed to join in. Fifteen of the 27 students were drawn from the at risk group.

In the five sessions, the perceptions of the at risk students with respect to the three major elements of the learning context, i.e. relationships, textbooks and notes, and tests and examinations were addressed. All the sessions were conducted as group sessions with practical examples provided by the subject teacher. The author acted as group facilitator and explained the theoretical framework and the meaning of the different constructs. At the same time all the students were provided with a printout of their own study orchestrations as well as the meaning of the different subscales. As measure of academic performance, students' results on traditional class tests and examinations were used. Results on the first class test, which was taken before the intervention, were compared with later class tests and examination results. In each case the student was assigned a number according to his/her rank in that particular assessment. As indication of

improvement (or not) a comparison was made in terms of the change in rank of the student relative to the class group as a whole. A positive sign indicated an improvement and a negative sign deterioration in relative performance.

The author reported that by far the greater proportion of the students who participated in the intervention programme (22 or 81.4%) managed to improve their performance relative to the rest of the class group. The performance of only five students (18.5%) deteriorated. In some cases the relative improvement was 'quite dramatic' and ranged up to 32 places in a class group of 34.

Some criticism against this study needs to be voiced. Firstly, the sample size of fifteen "at risk" students was very small and results from this study will have to be interpreted with caution. Secondly, the author gave no indication of subject area or courses under investigation. Reference was made to results on the 'first test' which might imply that results from a single subject were used in the study. Unfortunately the author also did not attempt to quantify whether any placebo effect was present. In some cases, the mere extra attention these students received might have made them work harder, especially if only one subject was involved. If only one subject was under scrutiny, the author should have looked at performance on other concurrent subjects as well. He needs to indicate that results in other subjects had not perhaps deteriorated by the same degree as they showed improvement in this one subject. Improvement in a single subject actually does not provide much information. What if the entire class had failed at the end of the year? It might then not have mattered that the student had managed to improve his/her ranking in the class group. Or if the student had failed the whole year despite performing "better" in one subject, it would also not be of much use.

However, despite this critique, the study showed a lot of promise and the approach that was described must be viewed as a contribution to a growing body of studies that sought to address the same problem of reducing student attrition. It is important to note from this study that change in a student's study approach could still be effected after registration at a tertiary institution. The author concluded with the statement that it

appeared to be more difficult to bring about desirable change in the first year than in the second. In order to achieve significant qualitative changes in the study orchestration of first-year students, Parsons (1993) stressed that 'structural modifications' would have to be made to the role played by the content and methods of assessment of the students. He stressed particularly the fact that lecturers would have to change their approaches, together with the integration of methods to raise the perceptual awareness of students of key elements in the learning context.

In a recent study Koch and Mallon (1998) discussed the efficiency, quality, and effectiveness of supplemental instruction (SI) procedures at tertiary institutions. The authors clarified the fact that SI implied that a student remained a full part of his class group and carried a full academic load. SI sessions were thus in addition to mainstream lectures in a particular programme. The sessions differed from tutoring sessions as senior students who had previously passed the course facilitated them and all discussions were student-driven. The main focus in the sessions was the content of the subject and the process and strategies of understanding the content. The study designed by Koch and Mallon (1998) addressed the challenge of managing to provide sufficient evidence that the improved academic performance and retention of students were attributable to SI and not to other factors which might have an effect on the students' performance. Their aim was also to provide evidence that these programmes achieved their objectives in the South African context.

In the study which was undertaken at the University of Port Elizabeth, SI was deemed to be successful in each course if the attendance at these sessions was satisfactory, the quality of the sessions tallied with expectations, the pass rate in the course and the pass rate of the underprepared students exceeded 50% and it could be shown that the programme contributed to an increase in academic performance. Should attendance at the sessions be acceptable, but no relationship could be found between attendance and academic performance, then the assumption was made that students perceived the SI as worthwhile, even though this possible worth was not reflected in their performance. The authors explained that the evaluation criteria were still being refined and that they were not yet at a satisfactory stage at the time of publication.

Preliminary results from the study identified three areas of possible concern. These were the voluntary and added-on nature of SI, the unstructured approach of the sessions, as well as the low pass rate of the underprepared students in some courses in which they attended the sessions satisfactorily and where attendance at the sessions was related to an increase in their academic performance. The fact that students attended these sessions on a voluntary basis, might have created the opportunity for unmotivated students with an 'unacceptable work ethic' to not attend, or else to realize their need for attendance when it was too late to have any rescuing effect. They concluded from this result that SI might thus not necessarily have reached the very students that it targeted. Although students requested a more structured approach to the sessions, this did not lead to an acceptable pass rate among underprepared students. The authors concluded from this that SI might not be adequate to deal with all the problems experienced by underprepared students.

The authors also indicated the importance of the skills and ability of the facilitators. They needed, in addition to facilitating skills, also a good knowledge of the subject as well as an enthusiasm for the subject. It was found in many cases also that the contribution of the lecturers was not satisfactory and that sometimes the communication between the lecturers and the facilitators was poor. In conclusion the authors stressed the fact that lecturers should realize that SI should be an integral part of a course and that the level of their own involvement and commitment would have a significant effect on the success of the programme.

Koch and Mallon (1998) posed a number of very important questions regarding SI. Although they made it clear that they had not answered these questions, the questions are very important to the tertiary situation in South Africa and must be seen also in a wider perspective than just for SI as they were intended. In fact, the questions should be asked of all forms of support provided at tertiary institutions. The questions are:

- * Who are the students who attend (supplementary instruction)?
- * Who should attend?
- * Why, if (supplementary instruction) is beneficial do students not attend to a greater extent?

- * How many times does a student have to attend (supplementary instruction) for benefit to be optimal?
- * How do we define and measure benefit?

3.2.2.1.1 CONCLUSION

The literature reviewed above indicated that a number of researchers (Guri-Rozenblit 1990; Simpson & Budd 1990; Scholtz 1991; Parsons 1993; Grobler 1994; Segal *et al.* 1999) showed that intervention programmes applied timeously could save many of the at risk students from attrition.

The studies on student support reviewed in this section were mostly those that emanated from South African tertiary institutions in recent years. These studies described or discussed various types of and approaches to student support such as:

- * An interview where the student could discuss his/her choice of career, a study methods course, as well as group therapy (Scholtz 1991);
- * A differentiated teaching model (Grobler 1994);
- * Attempts to change students' study methods from surface to deep approaches (Parsons 1993);
- * Supplemental instruction (Koch & Mallon 1998).

It must be understood, though, that many more types of support programmes exist and that these papers were individual reports from researchers in the field. No indication emerged from the literature that any institutional concern was behind the research.

The important fact that did emerge from every one of the reviewed studies was that student support in the post-registration period could have a lot of value in reducing attrition rates from tertiary institutions. The most important part of management of attrition in this post-registration period must thus be the ability to objectively and accurately identify those students who are at risk of failing. If such identification could be done early in the first year of studies, then student support could still make a difference to a student's academic outcome at the end of the year. Identification of the at risk students would also mean that expensive support programmes could be tailored for and delivered only to those students that require it and would benefit from it.

Particularly the first two questions posed by Koch and Mallon (1998) and listed above should thus be of enormous importance to tertiary institutions for at least two main reasons. Firstly, because student attrition rates affect State funding and institutional credibility and secondly, because student support programmes are expensive and must be viewed against the declining financial situations of tertiary institutions (Gourley 1992). In re-phrasing those questions from an institutional viewpoint one should then ask:

- * How do tertiary institutions decide which students need support?
- * On what basis do they do their "early identification" of the student at risk?

3.2.2.2 EARLY IDENTIFICATION OF THE STUDENT AT RISK

A review of the available literature indicated that many authors advocated the early identification of students at risk of failing (Young 1989; Potter & Van der Merwe 1993; Larose & Roy 1995; Campbell & Dickson 1996). However, not much actual research towards the development and/or testing of procedures for the early identification of the student at risk could be found.

Pantages and Creedon (1978) reviewed early studies on college attrition (1950-1975) and found that a number of the authors indicated that a highly significant relationship existed

between first semester college grades and attrition. The authors stated that these results were an indication that good grades were effective reinforcers that maintained and strengthened a student's academic performance and decreased the chances of that student dropping out. The authors claimed that, if a student was initially unsuccessful, they might develop a 'failure identity', which would increase the odds of that student's dropping out of college. It might also just be that students who did well in the first tests were actually academically superior to other students. It was also just as probable that those students who received a low grade and consequently dropped out were not overreacting, but were only realistically evaluating their potential for college work.

Studies that examine the relationship between first semester college grades and subsequent attrition rates are subject to several limitations. Summerskill (1965) cautioned that poor grades were a far more stable predictor of attrition than good grades were a predictor of retention, since successful students dropped out in larger numbers than would be expected.

Van Overwalle (1989) explored the relationship between achievement at university and self-reported characteristics of the students and their social environment at a Belgian (Dutch-speaking) university. The authors reported that social characteristics of students had been chosen as the target of investigation because they were directly measurable and, more importantly, more easily alterable, without major restructuring of the classroom environment, retraining of teachers or reorientation of university policy.

About one third (324) of the freshman population enrolled at the (Dutch) Free University of Brussels, Belgium were selected randomly. Participating freshmen were interviewed twice. The first interview covered their social and study experiences during the first semester, and the second one dealt with the preparation of the final examinations in the first year. Determinants of academic achievement were selected on the basis of significant correlations ($p < .01$) with the grades obtained from the final examinations in the freshman year. Unfortunately the author gave no indication of whether these grades were single grades per subject or grade point averages.

From this sample, 240 (71%) students participated at the first interview taken before the final examinations of the first year but only 184 students (57% of the total sample) cooperated for the second interview after the finals. A serious criticism of this study must center on this smaller number in the second list of interviews. The author indicated that this happened 'since many students who had failed their first year had left the university and were unable or unwilling to cooperate for a second time'. The researcher therefore worked with a skewed sample, as only students who were successful in the first year were included in the second interview. Results obtained might have been different had the failures also been included.

The most salient factor of student achievement revealed in this study was prior performance at midterm tests. Midterm results showed the strongest associations with academic performance in the first year (mean $r = .65$). In contrast, other behavioural data such as exercises and other assignments during the year did not relate significantly with final results. The author offered the possible explanation that such tasks were less representative of typical exams and were also taken less into account for the overall grading at the end of the year. Evaluation of one's ability as a student and of study strategies followed next in order of importance as performance indicators. These were academic self-concept, expectancies of success, study timing and working strategies (their general efficacy rather than a specific method, as associations with deep and surface strategies remained insignificant). Other substantial associations were observed with regular study effort (including attending lectures), general satisfaction with choice of study (rather than specific interest in the material), and prior knowledge. Significant associations were also found with structuring of knowledge, difficulty of tests, help and support from others, information and directions on exams, fear of exams, and teacher attitude. Various other characteristics that were closely related to the study such as social aid for study problems, study effort, interest in the study option, verbal ability, prior knowledge and understanding of the subject matter also showed low to moderate correlations with academic performance.

These findings led to the conclusion that factors inside the educational context, in this case the university, bore the strongest impact on participants' outcome. For example, study-focused social help and support, ability in academic matters, and so forth, were very important in determining the academic success of freshmen. In contrast, it was found that factors outside the immediate academic environment, such as leisure time activities or socio-economic background had little impact on educational attainment. It was found that determinants of academic achievement could be divided in two sets: factors that were controllable by the student or other persons (e.g. teachers), and factors that were less controllable. This distinction could be further split up according to the well-known property of locus, that is, factors that are internal to the student versus factors that are external (e.g. others or circumstances).

Only two studies could be found from medical schools on the topic of early identification of the student at risk. In a very good study Croen *et al.* (1991) developed a performance-based prediction model for the early identification of medical students at risk of developing academic problems. As background to the study the authors explained that, despite careful reviews of applicants' academic records and letters of recommendation, as well as additional scrutiny during interviews, every year medical schools in the USA accepted a number of students who encountered substantial difficulty in coping with the curriculum. A study of 30 medical schools indicated, for example, that 6.7% of the students had graduation delayed or withheld because of academic failure. It was also found that existing prediction models appeared to have limited ability to identify individual students who might have academic problems. It was felt that the high competitiveness that existed in medical school applicants might have led to restricted ranges of medical students' scores on the MCAT as well as their undergraduate grade point averages (GPAs) which could perhaps result in under-estimates of the predictive powers of these variables.

The Croen *et al.* (1991) investigation consisted of both a retrospective and a prospective study. In the retrospective study were included the classes of 1988 and 1989 at the Albert Einstein College of Medicine in New York. After excluding students with

missing data as well as 96 students who participated in an advanced biochemistry course that did not administer an examination after 3 months, the final sample consisted of 247 students. In a step-wise multiple regression analysis, third-month examination scores from four required first year courses were used as predictor variables and the weighted aggregate scores for all basic science courses in year one and year 2 were used as criterion variables. For each year, the criterion variable was computed for each student by weighting the standard score for each course by the number of contact hours, summing these, and dividing by the number of courses completed per year.

Unfortunately the authors gave no explanation of the rationale behind the process of weighting developed for the criterion variables. The use of contact hours as a weighting mechanism might need some careful consideration. All four the subjects selected as criterion variables were basic science courses that obviously had practical components as well. It might be unrealistic to take the actual contact hours as an indication of standard or difficulty level as some subjects (such as anatomy) might require more practical hours than others. This decision is even more difficult to understand if credence is given to a generally-accepted belief in medical education that some basic science departments tend to load their contact hours in order to get a bigger slice from the general resource allocation. This part of the research might need to be carefully explained by the authors. They also mentioned the fact that the procedure of weighting 'made it possible to retain in the sample those students for whom there were any missing data from December through June'. Unfortunately no explanation was given as to what they exactly meant by that statement. The authors also reported that, as there were often students who encountered serious academic problems during the first year of medical school, this was considered critical. They admitted that year-one predictor and criterion variables were slightly interdependent; however, the predictor variables were unweighted and constituted less than 1% of the total weighted year one score. Step-wise regression analyses were computed for each class, but as no significant difference was found between classes, only the combined data were reported.

The results of the retrospective study indicated that the first three criterion grades entered into the stepwise regression equation accounted for 76% of the variance in year one and 41% in year two.

Cumulative R squared (and F) values, as the four variables were added to the regression equation, were as follows for year one scores:

Subject	Cumulative R squared	F
Anatomy midterm	0.55	296.15
Biochemistry midterm	0.70	289.91
Histology grade	0.76	252.22
Embryology midterm	0.78	211.70

For year-two scores the values were:

Subject	Cumulative R squared	F
Anatomy midterm	0.29	95.93
Embryology midterm	0.37	68.87
Biochemistry midterm	0.41	54.77
Histology grade	0.42	41.46

All F-values were significant at the $p < .0001$ level.

Croen *et al.* (1991) thus showed a strong relationship between 3-month examination scores and academic performance at the end of the first year of studies. As far as performance in individual subjects were concerned, it was found that marginal performance on one or two of the early examinations was not a strong predictor of comparable performance at year end. However, 'pervasive marginal performance' on these early examinations was found to be highly predictive of similar academic performance throughout the first and the second years. The authors reported that of the

67 students who had scored in the lowest quarter of the class in one subject out of the possible four subjects in the 3-month examinations, 11% scored in the lowest quarter of the class at the end of the first year as measured by the weighted aggregate scores for all four of the basic science subjects. However, with marginal performance in more first-year subjects, poor results at the end of the year became more probable. For example, of the 39 students who had scored in the lowest quarter of the class in two out of the four subjects in this 3-month examination period, 47% scored in the lowest quarter of the class at the end of the first year. It was found that the situation became even worse with marginal performance in three of the four subjects at the 3-months examination period as 73% of the 30 students who scored in the lowest quarter in three of their subjects either again scored in the lowest quarter at the end of the year or did not progress into the second year. This observation also counted for the second year where 64% of the students who had scored in the lowest quarter in three of their four early first-year examinations had similar problems. Also all 10 students who scored in the lowest quarter in four of their subjects were also in the lowest quarter at the end of both years one and two.

In the prospective phase of the study, the authors applied the prediction model developed in the first phase to data from the class of 1992. Students whose grades were in the lowest quarter of their class on 3 of the 4 examinations administered in November of year one were identified as having marginal academic performance and their performance was studied prospectively. Croen *et al.* (1991) reported that the prediction model identified 17 students who had scored in the lowest quarter of the class on at least 3 of the year-one November examinations. They also reported that 15 (88%) of these 17 students had failed one or more courses by the end of the first year and that only one of these 17 students had completed year one in good academic standing.

The students correctly identified by the prediction model made up 77% of all the students in the class who encountered serious academic problems during the first year, and all but three who failed more than two courses. The authors thus indicated that the prediction method had a sensitivity of .77 and a specificity of .99. They also reported that, by the

end of the second year, two of the 17 students identified as being at risk after three months of the first year, had withdrawn, two were on leave of absence, and six were in decelerated programmes. All seven remaining students failed their National Board of Medical Examiners (NBME) examinations. However, it is important to note that in their third year clinical rotations the evaluations of these 7 students were comparable to those obtained by the class as a whole.

The authors concluded with the statement that, in both of these studies, the prediction model was useful in the early identification of students who encountered substantial academic problems during the preclinical component of their training. Marginal performance in three or more courses during the third month of medical school provided a much more reliable basis for identifying individual students who might have academic problems during the preclinical phase of their training than did undergraduate GPAs and/or scores on the MCAT. From the data available at selection, most of these students were not readily identifiable as being at risk, and all had been judged by the admission committee to have excellent potential for careers in medicine.

Despite the last statement by the authors, one cannot but feel that the applications committee might not necessarily have made a mistake in selecting these students, as their subsequent performances on the wards supported the decision to accept them. Given the potential for successful clinical performance of many students who encounter academic difficulty in the preclinical curriculum, it seems appropriate to try to identify those who are at risk as early as possible. For most, the provision of extra assistance, counseling, or a reduced course load should avert or minimize academic difficulties.

The main aim of the Croen *et al.* (1991) study was the development of a predictive model for the early identification of the student in serious academic difficulty. Although the specificity of the prediction model (.99 or 99%) was excellent, the aim of the study was not to find the potentially successful students, as they would continue to be successful without institutional intervention. The sensitivity of the model should therefore be of more value to the institution. The reported sensitivity of .77 or 77% indicates a good

model which accurately identified 77% of the potentially at risk students. However, one must also remember that almost 25% of the students in serious academic difficulty were missed by this model which indicates that the model was good, but perhaps not quite good enough. One would rather prefer a model that would “overpredict” the student at risk as extra support could only benefit a marginal student rather than missing the student and not providing the required support that might save his/her academic career.

In the second study from medical schools, Segal *et al.* (1999) explained that at the University of Michigan Medical School, the support programme started with a referral. This could be made by the student himself, by an academic counselor, or by a faculty member. To be referred, a student had to be seen as being academically at risk. Students were automatically referred if they were on academic warning or were seen to be in danger of academic warning. It appeared from this publication as though no very clear objective method of identification of the student at risk academically existed.

Although a number of South African researchers described support programmes aimed at the student at risk, not many researchers actually attempted to develop an objective method for the early identification of the student at risk of failing. Scholtz (1991) explained as background to his study that, although most South African tertiary institutions offered support programmes of some kind, no attempt was made to identify students at risk in a scientific manner and then to develop support programmes that specifically addressed their identified problems. He therefore designed a study (previously reported in Section 3.2.2.1) whereby psychometric test results were used to identify students at risk within the first two weeks after registration.

The author reported that statistical analyses indicated that the psychometric test scores obtained during the first week on campus discriminated well between the academically successful and academically at risk first-year students. The study was initially conducted on the 1984 intake and repeated on the 1985 intake of new first-year students with exactly the same results. The decision was then taken to use this study in a preventative manner and discriminant analysis was applied immediately to the psychometric results of

the 1987 first-year students. On the basis of these results a total of 172 possibly at risk students were identified from a global 843 first-year students. A support programme was then designed for these at risk students.

Other South African researchers looked at various aspects of early identification of the student at risk. Fourie and Naude-De Jager (1992) approached the problem of the extremely high failure rate (100% in 1988) amongst black students studying physics at South African technikons by means of a questionnaire addressed to all physics lecturers at technikons. The aim of this study was to try and identify a set of variables which would identify students at risk of failing physics even though the “normal” selection procedures identified them as being able to cope with a particular programme of study. As no measuring instrument existed for the identification of students at risk of failing physics, the researchers constructed a questionnaire in order to measure aspects such as students’ language ability, emotional maturity, motor skills, academic ability, ability to practically implement theoretical knowledge, ability to work independently, familiarity with physics apparatus, interest in the technical aspects of physics practical work, as well as a sense of responsibility.

Lecturers in physics at the different technikons were selected as contacts and questionnaires were sent to physics lecturers at 9 of the 12 South African technikons. Two technikons had only black students and were excluded as it would not be possible to compare black students with the other students. Technikon RSA was also excluded as it is an exclusively distance learning institution and comparisons with the residential technikons might not have been possible due particularly to the manner in which physics practicals were offered by Technikon RSA. Of the nine selected technikons, six responded, which brought the number of responses from physics lecturers to sixteen.

As it was expected that the largest percentage students at risk of failing physics would be from the black population group, the two groups selected for comparison were firstly black physics students, and secondly the rest of the physics students at technikons. This research covered only the responses of the 16 physics lecturers with regard to these two

independent groups of students. Comparisons of the data were done by means of the Mann-Whitney U test per individual question in order to determine the significance of the responses regarding the two groups. The areas where a significant difference could be demonstrated between the two groups were:

Language ability

Motor skills

Application of theoretical knowledge

Familiarity with Physics apparatus

Apart from language ability, the other three variables identified were all indications of a disadvantaged academic background in secondary school.

A criticism of this study is the fact that the whole study was based on lecturers' perceptions. Perhaps a study to investigate these abilities directly with the students involved would be a better indication of the actual problem. The group of responses (16) was also very small and could, at best, serve to indicate some trends.

Grobler (1993; 1994) used first test results to identify the at risk students. The identification of the at risk students was done in order to investigate the effectiveness of a differentiated teaching model on a group of first-year Physiological Psychology students at the University of the Orange Free State (already reported in Section 3.2.2.1). The students were divided into three groups on the basis of their scores in the first class test. The good students (75% and higher) were given additional reading work as stimulation, whilst the weaker students (< 60%) were seen as an at risk group and received supportive material. The middle group (60-74%) served as a control group in order to see whether the fact that a student took part in such an experiment alone would improve his/her performance.

Parsons (1993) approached student support from the perspective of approaches to learning, i.e. deep and surface approaches. Possibly at risk students were defined as

those who manifested a disintegrated meaning orchestration which both theoretically and empirically was associated with academic failure, and who obtained less than 50% on the first class test.

3.2.2.2.1 CONCLUSION

The published studies reviewed in this section covered various approaches to the identification of the student at risk, such as self-reported student characteristics (Van Overwalle 1989), third-month exams (Croen *et al.* 1991), first test results (Grobler 1993; 1994), psychometric tests (Scholtz 1991), approaches to learning (Parsons 1993) and an undefined method of identifying medical students "on academic warning" (Segal *et al.* 1999:384). All these studies must be seen as honest attempts to address a very serious problem, but one tends to get the impression that most of the work stemmed from individual concern. From the South African studies, for example, no indication was given that institutional policy (or even institutional concern) was behind the research.

Apart from the very superficial study by Fourie and Naude-De Jager (1992), no study emanating from an actual academic department could be found. It appeared as though most research on student support were undertaken by staff in the Support Departments and most of the strategies developed for the early identification of the student at risk, thus appeared to be aimed at the identification of students in order to test a specific support programme (e.g. Scholtz 1991; Grobler 1993; Grobler 1994; Parsons 1993). If this is the case, it is not surprising that a support programme such as SI is always an add-on to an academic programme and that attendance is mostly on a voluntary basis (Koch & Mallon 1998). This would also explain other concerns raised in the Koch and Mallon (1998) study such as the fact that subject lecturers were found to be uncommitted and uninvolved.

The fact that no research emanated from academic departments, together with no indication of clear institutional involvement, would also explain why many researchers

(Baumgart & Johnstone 1977; Martenson & Brattenbo 1992; Grobler 1994; Koch & Mallon 1998) stressed the fact that teaching and learning practices needed to change in order to accommodate the student at risk. The fact that most studies emanated from support departments rather than from academic departments would also explain why such a wide variety of support programmes and identification methods was apparent. Little overlap in approach could be detected – it would appear as though every research study followed the research person(s) area of interest, for example approaches to learning or psychometric tests.

In the review of the available research on the early identification of the student at risk, only one study (Croen *et al.* 1991) provided a scientific rationale for their identification model. In the retrospective part of the study, unfortunately, actual grades in subjects were used as the criterion variable which, as mentioned before, does not provide clear help in the reduction of attrition as it gives no indication of the student who failed the year or fell behind his group and would therefore still be a financial burden to the institution. Actual grades could be influenced by many factors such as a particularly difficult test, or a number of large tests grouped together over a few days with no adequate learning time in between. If all the students in the class had lower than normal results, then actual grades were not of much value in the objective identification of the student in need of support. In addition, it must also be remembered that results from USA medical schools could not be directly applied to or compared with those from South Africa. Medical schools in the United States only take in students who had already completed their pre-professional studies and the students are therefore (usually) much older than our South African recent matriculants. Moreover, they have already proven that they can cope in tertiary studies. The Croen *et al.* (1991) study also reported a sensitivity of 77% which might be too low to be of much value as a management tool as the model "missed" almost 25% of the at risk students.

From South Africa encouraging initial results were obtained from the Scholtz (1991) study where psychometric test results obtained within the first one to two weeks after student registration were used to identify at risk freshmen. Unfortunately the sample size

used (18) was too small for firm conclusions to be drawn. As these tests were done so shortly after students arrived on campus and did not test academic integration into the systems of the institution, this study might prove to be more useful in the pre-registration rather than the post-registration phase of attrition management. Whilst pre-registration characteristics should not be used in a gatekeeping role to exclude all the potentially at risk applicants, the results from such tests would at least give the institution a “pre-warning” as to how many of the selected freshmen might be at risk and what the cost-implications of their selection policies thus might be.

Not a single study could be found that utilized test results from the different first-year subjects to develop an objective predictive model for the early identification of the freshmen in need of academic support.

3.3 SUMMARY AND CONCLUSION

The review of the literature indicated clearly that student attrition from tertiary institutions was a serious problem and that it had a negative impact on the cost-efficient management of tertiary institutions. It also became clear that the highest rates of attrition occurred in the freshman year. However, research results on attrition were not necessarily generalizable from one institution to another. Before using scarce resources to solve the problem of attrition, educational managers need accurate information on numbers of students who would need support in order to be successful. Educational management principles thus dictate that the problem of attrition should be quantified and the unique factors relating to discontinuation within its own province be identified and described for every programme in a tertiary institution. This fact guided the researcher to include a descriptive section to the present research in order to quantify the problem of attrition for the first three years of study (the pre-professional studies) in the two six-year programmes chiropractic and homoeopathy at Technikon Natal.

It became apparent from the theoretical models that attrition was a highly complex problem dependent on many characteristics and aspirations that a student brings to a

tertiary institution. It was shown that student academic performance and student psychological state are the result of interaction between these student characteristics and institutional factors. This interaction forms the basis for institutional exclusion and personal withdrawal decisions. Student attrition is thus a longitudinal process and it may be argued that any attempt to minimize this phenomenon must institute strategies both before registration as well as after registration.

Management of attrition in the pre-registration phase consists mainly of the implementation of different admissions policies and selection procedures. Student selection is the stage where the decision is taken to allow a specific student entry into a particular programme. In an attempt to reduce attrition rates and improve student retention and performance, a wide variety of selection procedures (either singly or in various combinations) as well as a wide variety of student characteristics (both cognitive and non-cognitive) was being employed to make such final decisions on who to admit and who to reject. In order to increase student diversity, different selection methods for different target groups were also used and some institutions had initiated development/bridging programmes to try and bring educationally disadvantaged students to a level where they could cope with tertiary studies. However, the effectiveness of any of these admissions strategies could only be judged after being properly researched and tested for correlation between those student characteristics that were available at the time of registration and either academic grades or success in tertiary studies.

The structured research to investigate the effectiveness of student selection was found to be most often an attempt to predict future quality grade point averages by making use of pre-registration data. However, the problem that concerns the tertiary institutions is not necessarily the knowledge of what scores prospective students could be expected to earn in their tertiary studies, but the problem of student attrition and persistence in tertiary studies. Although a number of researchers attempted to find those pre-registration characteristics that would identify the student at risk of failing, these studies were seriously affected by vague (and unique) categorizations of students at risk which made the results very difficult to apply meaningfully and to compare with other findings. Most of the researchers failed to differentiate between the different types of attrition and

simply tried to distinguish between students who were successful and students who were not. Most of the studies were end-point studies, in other words they only looked at those students who graduated. This must be seen as a serious flaw in the design of such studies, as no attention was given to problems around students who fell behind their classmates and graduated late. This finding was surprising, as dropback students should be as important as failures from an institutional viewpoint. Although they are not “lost” to the programme, they use up valuable resources by repeating a year and receiving costly support services.

Only cognitive pre-registration characteristics emerged as stable pre-registration variables for the prediction of both academic performance and successful completion of the first year of tertiary studies. Particularly school results appeared to have some value in the selection process. It did become apparent, though, that a substantial part of the variation in students’ academic performance was unpredictable from the evidence available at the time of registration and that the academic performance and attrition of disadvantaged students were very difficult to predict.

The literature review highlighted the fact that attrition rates around the world remained unacceptably high, and this might be an indication that the often very costly and resource-intensive selection policies and procedures in use were not able to select students effectively and efficiently. The conclusion that could be drawn is that the large number of characteristics that students bring to the institution, together with the different experiences that students have once they arrive on campus and which will react differently with their personal characteristics, might simply mean that the problem is too complex to allow for substantial reduction of attrition rates in the pre-registration phase. Pre-registration data might then, at best, be useful for screening purposes and it was concluded that institutions would have to focus on the post-registration period for any substantial reduction in attrition rates.

Research findings led to the further conclusion that factors inside the educational context, in other words inside the tertiary institution, bore the strongest impact on the academic

outcome of students. This was in agreement with the theoretical models of attrition discussed in Chapter Two. Student academic interaction, which appeared to be the major reason for attrition, could only be measured once a student had been assessed at the tertiary institution.

Research showed that support programmes had value in reducing attrition and improving academic performance. However, in order to identify the students who require such services, objective methods must be developed whereby the earliest signs of academic difficulty after the start of the first year could be identified.

Although a strong feeling apparently existed that first test results, or any other early form of assessment in the first year of studies, were good indicators of later success, this area had not been well researched as yet. No study could be found that attempted to use academic performance in the first year of studies to develop an objective model for the early identification of the freshman that would require support in order to be successful at the end of the first year. This fact guided the author to concentrate the present research on the development of an early warning system for the identification of the student at risk of failing the first year of studies in chiropractic and homoeopathy at Technikon Natal.

CHAPTER FOUR

RESEARCH METHOD

The objectives of this study was to firstly quantify and describe the problem of attrition in the programmes chiropractic and homoeopathy and then to develop an early warning system for the identification of the freshmen in need of support.

4.1 STUDY DESIGN

An *ex post facto* research design was selected because the predictor (independent) variables (performance in the first and second test series of the freshman year) had already occurred, and the researcher therefore started with the observation of the criterion (dependent) variable (the academic outcome of the same students at the end of the freshman year). In *ex post facto* research the data are collected after the presumed cause or causes have occurred and this kind of research design has to be relied on in those situations where the independent variable or variables lie outside the researcher's control and where the experimental method is therefore not possible. In the present study it would be very difficult to research the problem in an experimental manner as the researcher could not cause some of the students to become academic exclusions, dropbacks, or voluntary withdrawals. Existing data of necessity therefore formed the basis of the research (Cohen & Manion 1991).

In order to address the research questions, the research was approached in two phases. In order to investigate the phenomenon of attrition in the chiropractic and homoeopathy programmes, a descriptive design was first used. After quantification of the problem, an attempt was then made to establish the existence of a relationship between test results and academic outcome at the end of the freshman year and subsequently to develop predictive

models from the first and second test results in order to identify the freshmen in need of support. The research was thus conducted in the form of four separate studies addressing the following questions:

STUDY 1 DESCRIPTION OF THE PROBLEM

- * How serious is the problem of attrition?
- * Who is the student at risk?
- * When is the risk of attrition the highest?

STUDY 2 TEST 1 RESULTS AS PREDICTOR VARIABLES

- * Is there a relationship between results obtained in the first tests and success or failure at the end of the first year of studies?
- * Can a logistic regression model that will identify the freshmen at risk of failure be estimated from test one results?
- * Can a logistic regression model estimated retrospectively from test one results be used for the early identification of future at risk freshmen?

STUDY 3 TEST 2 RESULTS AS PREDICTOR VARIABLES

- * Is there a relationship between results obtained in the second tests and success or failure at the end of the first year of studies?
- * Can a logistic regression model that will identify the freshmen at risk of failure be estimated from test two results?
- * Can a logistic regression model estimated retrospectively from test two results be used for the early identification of future at risk freshmen?

**STUDY 4 DISCRIMINANT ANALYSIS PROCEDURES UTILIZED TO
DISCRIMINATE BETWEEN SUCCESSFUL AND
UNSUCCESSFUL FRESHMEN**

- * Can discriminant analysis procedures be utilized to differentiate between successful and unsuccessful freshmen on the basis of their test 1 results?
- * Can discriminant analysis procedures be utilized to differentiate between successful and unsuccessful freshmen on the basis of their test 2 results?

4.2 SELECTION OF SUBJECTS

The study included all the students that were registered in the chiropractic and homoeopathy programmes from the first year they were offered namely 1989. Over the relevant nine years the following numbers of students were registered:

TABLE 1
NEW STUDENT NUMBERS

<i>YEAR OF INTAKE</i>	<i>CHIROPRACTIC</i>	<i>HOMOEOPATHY</i>
1989	34	34
1990	27	36
1991	35	33
1992	37	27
1993	35	32
1994	35	28
1995	33	32
1996	34	26
1997	35	30
1998	37	21
1999	47	17
TOTAL	389	316

Table 1 indicates the numbers of new students per year that registered for chiropractic and homoeopathy since the start of the two programmes. Although more students were registered in homoeopathy in 1990, since then the registrations in chiropractic had been consistently higher than those in homoeopathy where the student numbers showed a serious decline from the allotted 33 annual places.

TABLE 2

PERCENTAGE FEMALE STUDENTS

<i>YEAR OF INTAKE</i>	<i>CHIROPRACTIC</i>	<i>HOMOEOPATHY</i>
1989	38	56
1990	22	50
1991	26	64
1992	27	59
1993	40	72
1994	49	64
1995	61	59
1996	35	77
1997	34	73
1998	51	71
AVERAGE	37	64

Table 2 shows that over the ten years investigated, the homoeopathy programme attracted a preponderance of female freshmen (64% on average as opposed to the 37% in chiropractic). The chiropractic programme on the other hand attracted a majority of male freshmen (63% on average as opposed to the 36% of the homoeopathy programme).

TABLE 3**PERCENTAGE OLDER STUDENTS**

<i>YEAR OF INTAKE</i>	<i>CHIROPRACTIC</i>	<i>HOMOEOPATHY</i>
1989	71	62
1990	41	44
1991	71	61
1992	58	44
1993	51	62
1994	57	46
1995	36	41
1996	50	62
1997	37	43
AVERAGE	52	52

Table 3 indicates that, although individual fluctuations between the percentages of first-time freshmen and the older group occurred from year to year, on average no difference could be detected between the two programmes as far as the relative percentages of older and first-time freshmen were concerned as both groups had on average slightly more older freshmen (52% as opposed to the 48% first-time freshmen).

4.3 DATA

All information used in this research was obtained from the students' computerised record cards.

4.3.1 PREDICTOR (INDEPENDENT) VARIABLES

4.3.1.1 FIRST TEST RESULTS

The actual percentage scores obtained in the first tests of the following first-year subjects were used as predictor variables:

- * Physiology
- * Anatomy
- * Biology
- * Chemistry
- * Physics

The remaining subject philosophy, history and principles I was a second semester subject for the years under investigation. The first tests were written later in the year and this subject could therefore not be included in the present research.

4.3.1.2 SECOND TEST RESULTS

The actual percentage scores obtained in the second tests of the following first-year subjects were used as predictor variables:

- * Physiology
- * Anatomy
- * Biology
- * Chemistry
- * Physics

The results of philosophy, history and principles I were again not included for the same reasons as given above.

4.3.2 CRITERION (DEPENDENT) VARIABLES

On the basis of their academic performance at the end of the first, second, and third years of study in the chiropractic or homoeopathy programmes all students were categorized in the following manner:

1. SUCCESSFUL	Students that pass all subjects at one examination period (final examination plus supplementary examination sessions) and are thus on target to complete the programme in the minimum time period.
2. DROPPACKS	Students that become “hybrids” in that they carry some subject/s and therefore fall one or more years behind their peers.
3. ACADEMIC DISMISSALS	Students that fail three or more subjects in their first year or fail a major subject twice and are then not allowed to re-register for the programme
4. VOLUNTARY WITHDRAWALS	Students that leave of their own accord

In order to categorize students, the final results obtained at the end of each year were used. The examination period was considered as consisting of both the end of year as

well as the supplementary examination. A pass in a particular subject was thus accepted if the student managed to pass either in the final examination or in the supplementary examination.

The first three years of the two six-year programmes consist of the following subjects:

YEAR	CHIROPRACTIC	HOMOEOPATHY
FIRST	Anatomy I Physiology I Philosophy, History & Principles I Biology I Chemistry I Physics I	Anatomy I Physiology I Philosophy, History & Principles I Biology I Chemistry I Physics I
SECOND	Anatomy II Biochemistry II # Epidemiology II General Pathology II # Medical Microbiology II # Physiology II Social Studies II #	Anatomy II Biochemistry II # Epidemiology II General Pathology II # Medical Microbiology II # Physiology II Social Studies II #
THIRD	Auxiliary Therapeutics III Diagnostics III Psychopathology III Systemic Pathology III *Chiropractic Principles & Practice III	Auxiliary Therapeutics III Diagnostics III Psychopathology III Systemic Pathology III *Materia Medica III

Indicates a semester subject.

* Denotes a subject difference between the two programmes.

To determine the academic categorization of each student, the passes obtained in the specific subjects were considered together with the actual departmental rules as stated in the Departmental Handbooks and given below.

Pass requirements for the Department of Chiropractic (Technikon Natal 2000a) for the first three years of study are indicated as:

1. A student shall obtain a minimum of 50% in a subject to pass that subject.
2. The final mark will be made up of 60% of the examination mark and 40% of the year mark.
3. A sub-minimum of 40% shall apply to theory, oral and practical examinations as well as the semester/year mark.
4. Notwithstanding Rule 3 above, a sub-minimum of 50% shall apply to the examinations as well as the year marks of Auxiliary Therapeutics III, Diagnostics III, and Chiropractic Principles and Practice III.
5. Class attendance, class tests, practical laboratory work, practical clinic work and projects will be taken into consideration to determine the year/semester mark.
6. Subject successes may be accumulated.
7. A student may deregister from a maximum of 50% of all first-year subjects, as agreed to with the Head of Department, without such constituting a fail in such subjects, provided such de-registration occurs on or before the last day of the first semester. Any first-year student de-registering from a subject on or before the last day of the first semester, may be required, that year, to attend an educational development programme to the satisfaction of the Head of Department of Chiropractic.

8. A first-year student who fails 50% or more of the subjects for which he/she is registered after the last day of the first semester of that year, will not be permitted to re-register in the Department of Chiropractic.
9. A student shall not be allowed to register for any subject in the third year if he/she has not completed the Basic Ambulance Certificate or its equivalent.
10. Notwithstanding the General Rule G15(10) a year/semester mark obtained for any subject, or for any module of a subject in the case of Chiropractic Principles and Practice III, is only valid for the main examination in the year/semester in which a student is registered plus the supplementary examination in that subject if granted to the student in terms of the General Rule G16(3).
11. A student who fails any subject when repeating that subject, will not be permitted to re-register in the Department of Chiropractic. This shall apply regardless of whether the student was registered as a chiropractic or a homoeopathy student when he/she first failed the subject.
12. Students, who repeat any subject in the 3rd year, must also repeat Chiropractic Principles and Practice III and Diagnostics III, their original year marks in these two subjects falling away. These two subjects must also be successfully completed in the calendar year preceding their commencement of the fourth year.

Pass requirements for the Department of Homoeopathy (Technikon Natal 2000b) for the first three years of study are indicated as:

1. A student shall obtain a minimum of 50% in a subject to pass that subject.
2. The final mark will be made up of 60% of the examination mark and 40% of the year mark.

3. A sub-minimum applies to theory, oral and practical examinations and year marks. This sub-minimum is 50% for Materia Medica III and 40% for all other subjects.
4. Subject successes may be accumulated, except in the case of Materia Medica III when Rule 8 applies.
5. A first-year student who fails three or more subjects during that year is not permitted to re-register in the Department of Homoeopathy.
6. A student is not permitted to register for the fourth year if he/she has not completed the Basic Ambulance Certificate or its equivalent.
7. Notwithstanding the General Rule G15(10) a year/semester mark obtained for any subject is only valid for the main examination in the year/semester in which a student is registered plus the supplementary examination in that subject if granted to the student in terms of the General Rule G16(3).
8. A student who fails any subject in the third year must re-register for that subject as well as for Materia Medica III, with any previously attained year marks for the failed subject/s and Materia Medica III falling away.
9. A student who fails any subject after two registrations for that subject, will not be permitted to re-register in the Department of Homoeopathy. This shall apply regardless of whether the student was registered as a chiropractic or a homoeopathy student when he/she first failed the subject.

In addition to the above Departmental Rules which are slightly different for the two programmes, exactly the same **pre-requisite and co-requisite subjects** apply for the second and third years of study. Pre-requisite subjects are subjects which a student must pass before registering for the subjects specified in the first column. Co-requisite (or

complementary subjects) are subjects for which a student must register and write all tests, but not necessarily pass, prior to, or simultaneously with, the specified subjects in the first column.

SECOND YEAR

SUBJECT	PRE-REQUISITE	CO-REQUISITE
Biochemistry II	Chemistry I Physiology I Biology I	Physiology II
General Pathology II	Biology I Anatomy I Physiology I	Physiology II Medical Microbiology II Epidemiology II
Epidemiology II	Biology I	Medical Microbiology II
Physiology II	Biology I Physiology I Chemistry I Physics I	Biochemistry II General Pathology II
Anatomy II	Anatomy I	

THIRD YEAR

SUBJECT	PRE-REQUISITE	CO-REQUISITE
Auxiliary Therapy III	Physiology II Anatomy II General Pathology II	Systemic Pathology III
Diagnostics III	All 1st year and 2 nd year subjects	Systemic Pathology III Biochemistry II
Psychopathology III	Social Studies II	
Systemic Pathology III	General Pathology II Anatomy II Physiology II	
<u>Chiropractic:</u> Chiropractic principles and Practice III	Physiology II Anatomy II	
<u>Homoeopathy:</u> Materia Medica III	All 1 st and 2 nd year subjects	

In order to investigate the problem of attrition, the academic status of each student at the end of the first, second and third years of study was coded as successful, dropback, academic dismissal, or voluntary withdrawal. As the departmental rules for the two programmes are slightly different, with the chiropractic rules being more stringent, the coding process would have had slightly different outcomes for the two groups of students.

4.4 STATISTICAL TECHNIQUES

4.4.1 DESCRIPTIVE TECHNIQUES

Descriptive techniques are useful for establishing an overview or picture of a suspected problem. This descriptive study was thus undertaken in order to quantify and describe the problem of attrition in the programmes chiropractic and homoeopathy and to answer the following questions:

- * How serious is the problem of attrition?
- * Who is the student at risk?
- * When is the risk of attrition the greatest?

Of specific importance in an investigation of attrition are the following calculations:

- * Percentage successful students (coded as 1);
- * Percentage students “lost” to the system – i.e. academic exclusions (coded as 3) plus voluntary withdrawals (coded as 4); and
- * Percentage at risk students – i.e. dropbacks (coded as 2) plus academic exclusions (coded as 3).

These percentages were calculated and tabulated.

The high attrition rates that still occurred in the second and third years of these two programmes guided the researcher to also follow prospectively the academic outcome of those students who became dropbacks in their first year of study. Should their future academic prowess be satisfactory, then it might not be necessary for an institution to provide such (perhaps) marginally at risk students with costly support programmes. However, if it could be shown that they experienced serious academic difficulties over the next two years, it would make a case for the timeous provision of support to them as

early as possible in their freshman year. The academic fate of these dropback students at the end of the next two years of study was thus also tabulated.

4.4.2 INVESTIGATING THE EXISTENCE OF A RELATIONSHIP BETWEEN TEST RESULTS AND ACADEMIC OUTCOME AT THE END OF THE FRESHMAN YEAR

Not a single study could be found which had actually shown that a direct relationship existed between first test results and academic outcome at the end of the freshman year, or between second test results and academic outcome at the end of the freshman year. The investigations undertaken in this section of the research were thus to attempt to show the existence of such a relationship. Calculations were done separately for the chiropractic and homoeopathy programmes.

It was argued that the voluntary withdrawal group had left the institution because of a large number of different reasons, not all of them academic. As the main aim of the present research was the early identification of the freshman in need of support, the voluntary withdrawal group was excluded from this part of the investigation. Only three categories of academic outcome were thus used, i.e. successful, dropback and academic exclusion.

After students had been categorized into these three categories, separate lists were created which consisted of all the students over the nine years investigated who fell in one of those categories. For example, all the students who were classified as academic exclusions (coded as 3) were put together in one list. For each one of these groupings students were again classified, per subject, according to their performance in the first tests.

With physiology first test results as an example, all test results were divided into the following scoring brackets:

<9%
 10-19%
 20-29%
 30-39%
 40-49%
 50-59%
 60-69%
 70-79%
 80-89%
 >90%

In each one of those test result brackets the numbers of students per coding category were calculated. The following extract from a Table illustrates the calculations:

	CHIROPRACTIC	HOMOEOPATHY
Students with 50-59%	1 39 59%)	1 25 56%)
	2 17 26%)) 85%	2 9 20%)) 76%
	3 10 15%) 41%	3 11 24%) 44%
	Total 66 (27%)	Total 45 (18%)

For example, 66 chiropractic freshmen scored in the 50-59% bracket over the nine years investigated. It was then calculated that this 66 represented 27% of all the chiropractic freshmen who had taken physiology over the nine year period, or that 27% of all chiropractic students had scored in the 50-59% bracket for the first physiology test of their freshman year. Of those 66 chiropractic freshmen who had scored in the 50-59% bracket in the first physiology test, 39 (59%) eventually were successful, 17 (26%)

became dropbacks, and 10 (15%) became academic exclusions. It was then argued that of these students, all those who were successful and became dropbacks were retained (remained in the system), whilst all those who were dropbacks and academic exclusions were at risk academically and therefore in need of support. Calculating those percentages from the figures given above would indicate that $59\% + 26\% = 85\%$ of the chiropractic freshmen who had scored in the 50-59% bracket in the first physiology test remained in the system. It would also indicate that $26\% + 15\% = 41\%$ of the chiropractic freshmen who had scored in the 50-59% bracket in the first physiology test were in need of support in order to become successful.

The same calculations were done for every one of the test result brackets for every predictor variable and the information was then tabulated in the following manner:

For each predictor variable, namely the first test results in physiology, anatomy, biology, chemistry and physics, the same procedure was followed. From the resulting tables, four graphs were then constructed for each subject. Again taking the first test results in physiology as an example, the following graphs were constructed:

- * Percentage successful freshmen per average physiology test one results.
- * Percentage freshmen who became academic exclusions per average physiology test one results.
- * Percentage freshmen who remained in the system per average physiology test one results.
- * Percentage freshmen who would require support per average physiology test one results.

The whole procedure explained above was then repeated for the second test results in physiology, anatomy, biology, chemistry and physics.

4.4.3 STATISTICAL ANALYSES

Data entry and statistical analyses were performed using the statistical package SPSS.

The statistical analyses utilized in this research were used to:

- * Determine whether a significant relationship existed between performance in the first and second tests of the first year and whether students were successful at the end of the first year of studies or whether they would need support to enable them to successfully complete the year.
- * Develop prediction models for the early identification of the first-year student at academic risk.
- * Validate the prediction models.

Criteria are required for the early recognition of the student who needs support to prevent attrition from the institution. Criteria must therefore be developed to predict student success or at least to predict academic difficulties. Multiple regression analysis can only be used for an examination of the relationship between actual results and the independent variables. The prediction of actual scores is often not an indication of the academic outcome (successful / not successful) of a student at the end of a year of study or at the end of a whole programme. Such information is not of much use to an institution. What is actually required is an early identification of those students for whom the academic outcome at the end of the year might not be favourable so that support mechanisms can be implemented in order to retain such students and to help them towards success. It is also important for the institution to have this information about students in each programme, as strategic and financial planning should be based on such actual data.

It would be useful to be able to predict whether an event (whether or not a student passed the first year of study) will or will not occur, as well as to be able to identify those variables that are useful in making the prediction. When the dependent variable can have only two values (successful or not successful), the assumptions necessary for hypothesis testing in regression analysis, such as an assumption that the distribution of errors is normal, are not met. Predicted values generated by multiple regression analysis can also not be interpreted as probabilities as they are not constrained to fall in the interval between 0 and 1. Multiple regression procedures are thus not able to provide criteria that could be used to predict attrition or success of students. Further, the scope of multiple regression is also limited to those students who complete the course and are assigned a final score.

Statistical procedures able to provide criteria for the prediction of outcome variables such as whether or not a student passed the first year of studies are:

- * Logistic Regression
- * Discriminant Analysis

4.4.3.1 LOGISTIC REGRESSION

Logistic regression is a procedure particularly suited to the prediction of the presence or absence of a dichotomous characteristic or outcome such as successful/ not successful, based on values of a set of predictor (independent) variables. It can be used to describe the relationship between the dichotomous dependent variable and a set of predictor variables that may be either categorical or continuous. Logistic regression is also a procedure that provides an analysis of the relative contribution of each predictor variable toward the explanation of the dependent variable as the logistic regression coefficients can be used to estimate odds ratios for each of the independent variables in the model.

In logistic regression a direct estimate is made of the probability of an event occurring. In the case of more than one independent variable, the estimated logistic regression model is given as follows:

$$\Pr(Y = 1) = \frac{1}{1 + e^{-Z}} \text{ where}$$

$$Z = \hat{\beta}_0 + \hat{\beta}_1 X_1 + \hat{\beta}_2 X_2 + \dots + \hat{\beta}_k X_k \text{ where}$$

$\Pr(Y = 1)$ is the probability of failure

X_1, X_2, \dots, X_k are predictor variables

k is the number of predictor variables and

$\hat{\beta}_0, \hat{\beta}_1, \hat{\beta}_2, \dots, \hat{\beta}_k$ are estimated regression coefficients

Using the estimated logistic regression model, an estimation can be made of **the probability that $Y = 1$** (the probability that a student fails to succeed) for any given values of the independent variables, for any specific student.

The expression $\text{Exp}(\hat{\beta})$ is the factor by which the **likelihood of failure** is affected when the value of the independent variable associated with $\hat{\beta}$ changes from a low to a high level, where $\hat{\beta}$ is the estimated regression coefficient.

- (1) If the estimated regression, $\hat{\beta}$, is positive, then the expression $\text{Exp}(\hat{\beta})$ is greater than 1. In this case, the likelihood of failure is increased.
- (2) If the estimated regression, $\hat{\beta}$, is negative, then the expression $\text{Exp}(\hat{\beta})$ is smaller than 1. In this case, the likelihood of failure is decreased.
- (3) If the estimated regression, $\hat{\beta}$, is zero, then the expression $\text{Exp}(\hat{\beta})$ is equal to 1. In this case, the likelihood of failure remains unchanged.

4.4.3.1.1 DIAGNOSTIC PROCEDURES

Diagnostic procedures are measures of adequacy of the estimated logistic regression model. The following diagnostic procedures were used to test whether the model fitted the data well.

1. The overall percentage of correct classification

An overall percentage of correct classification of $\geq 75\%$ indicates that the estimated logistic regression model is reliable.

2. Observed significance levels or P-values for each variable

The ability of an independent variable to explain the variability in the dependent variable is significant if the associated P-value is less than the level of significance α . The level of significance was set at $\alpha = 0.05$.

3. Estimated standard errors

Small estimated standard errors indicate that the estimated logistic regression model performs well.

4. The proportion of change in the -2Loglikelihood statistic

A proportion of change in the -2Loglikelihood statistic from the beginning of the backward elimination procedure to the end of the procedure that is $> 10\%$ shows that the optimum model is good.

5. Normal probability plots for studentized, leverage, and deviance residuals

Fairly S-shaped normal probability plots for the residuals indicate that the error terms are approximately distributed normally.

4.4.3.1.2 MODEL VALIDATION

In order to validate a logistic regression model developed on a specific set of data, another set of data is drawn from the same universe. The optimum estimated logistic regression model developed retrospectively is then used to predict the outcome, in other words the probability that $Y = 1$ (or the probability of the student not being successful at the end of the first year of studies). The predicted results are then compared with the actual outcomes shown for the time period selected for model validation.

Two main types of potential predictive error are recognized.

- Type I error:** Rejecting a true null hypothesis.
 Thus believing that there is a problem when in fact there is no problem, i.e. predicting students to be at risk academically when in actual fact they are successful at the end of the year.
 False negative.
- Type II error:** Accepting a false null hypothesis.
 Accepting a false assurance that everything is well when in fact there is a problem, i.e. predicting students as being successful when in actual fact they are not (or missing potentially unsuccessful students).
 False positive. (Moore 1985: 328-332).

The power of a statistical test is a measure of how sensitive the test is. A statistical test is said to be sensitive (or powerful) if it has the capacity to reject a false null hypothesis.

The power of a test ($1-\beta$) depends on the size of the sample, the accuracy (precision) of measurements involved in the study, and the level of significance of the study, α . The smaller the power of a test, the larger becomes the likelihood of a Type II error (accepting the null hypothesis) (Portney & Watkins 1993).

In the present study sensitivity refers to the ability of the predictive model to act as a screening test for the correct identification of those students who were not successful at the end of the first year of studies, calculated as a percentage of all the students who actually were not successful at the end of the first year (the “true positive” rate). Specificity, on the other hand, refers to the proportion of successful students who were correctly identified by the predictive model (the predictive accuracy for a negative result) (Feinstein 1985; McDowell & Newell 1987).

4.4.3.2 DISCRIMINANT ANALYSIS

Discriminant analysis is a statistical procedure used to study differences among two or more mutually exclusive groups. Discriminant analysis is useful for the building of a predictive model of group membership based on observed characteristics of each case. The procedure generates a discriminant function (or a set of discriminant functions where there are more than two groups) based on linear combinations of the predictor variables that provide the best discrimination between the groups. The classification function coefficients that are based on Fisher’s linear discriminant function are generated from a sample of cases for which group membership is known and are used to assign or classify cases into groups. A case is predicted as being a member of the group in which the value of its classification function is largest. The coefficients are computed to maximize the distance between the two groups. The coefficients computed in a specific study can

also be used to classify any random sample drawn from the population of the study or the functions can then be applied to new cases with measurements for the predictor variables but unknown membership.

One of the necessary assumptions for discriminant analysis is equality of group covariance matrices. The stepwise discriminant procedure is used in order to build the most parsimonious model. In this procedure the statistically significant variable that contributes the most discrimination among the groups is entered first. The variable that contributes the next greatest amount of information to determine group membership is entered second. This procedure continues until the remaining variables contribute no additional discriminating information.

After this procedure is completed, the Wilks' Lambda values are calculated to determine the best combination of predictor variables for group membership. The Wilks' Lambda statistic tests the equality of the group centroids, in other words, how well separated the means or the centroids of the two groups are. Wilks' Lambda is a multivariate analysis of variance test statistic that varies between 0 and 1. Small values indicate that the group means differ strongly. Values close to 1 indicate that no difference exists between the group means. Wilks' Lambda is thus used to test the null hypothesis that the means of all the variables across groups are equal and provide little information regarding the success of the model for classifying cases. As a test of its size, Wilks' Lambda is transformed to a variable with an approximate chi-square distribution. The significance of the chi-square value indicates whether a significant difference exists between the two group centroids.

The structure matrix is a panel of within-groups correlations of each predictor variable with the canonical variable and provides a measure of the usefulness of each variable in the discriminant function.

4.4.3.2.1 DIAGNOSTIC PROCEDURES

Diagnostic procedures are measures of adequacy of the estimated discriminant analysis model. The following diagnostic procedures were used to test whether the model fitted the data well.

1. Eigenvalues

The eigenvalue is a ratio of the between-groups sum of squares to the within-groups or error sum of squares. Large eigenvalues indicate small error sum of squares.

2. Wilks' Lambda

Wilks' Lambda is the proportion of the total variance in the discriminant scores not explained by differences among the groups. If the P-value associated with the Wilks' Lambda statistic is smaller than the selected significance level of $\alpha = 0.05$, this serves as an indication that the criterion used to define group membership is objective.

3. Percentage of correct classification

A percentage of correct classification $\geq 75\%$ indicates that the estimated logistic regression model is reliable.

4.4.3.2.2 CROSS-VALIDATION OF THE MODEL

In a discriminant analysis computation the classified cases are the same as the cases used to estimate the coefficients and the tally of correctly classified and misclassified cases might thus be an optimistic estimate of the success of the classification. The ideal situation would be to compute the classification functions from one sample and use

another sample drawn from the same population to estimate the proportion misclassified. This procedure is called cross-validation and produces unbiased estimates. The leave-one-out cross-validation method can thus be employed to diminish the optimistic bias. In this procedure each case is classified into a group according to the classification functions computed from all the data except the case being classified. The proportion of misclassified cases after removing the effect of each case one at a time is the leave-one-out estimate of misclassification. It must be remembered, though, that if the goal of the study is to build a model for the classification of new cases, then the leave-one-out estimates may still be on the optimistic side.

4.5 CONCLUSION

The different techniques to be employed in the planned investigation were described above. In the next chapter the data generated in the investigation will be reported.

CHAPTER FIVE

RESULTS OF THE STUDY

5.1 STUDY 1 : THE CURRENT REALITY

In this descriptive study the problem of attrition in the chiropractic and homoeopathy programmes at Technikon Natal was investigated. According to their academic outcome at each of the first three years of study in these two six-year programmes all students were categorized as successful, dropback, academic exclusion, or voluntary withdrawal. This study was undertaken to investigate whether attrition in these two programmes was a problem serious enough to warrant time and resources spent on it. As a starting point the percentage of successful students was calculated for each year of study and the average percentage successful students for the period of investigation (1989 to 1997) was then calculated and tabulated.

TABLE 4

AVERAGE PERCENTAGE SUCCESSFUL STUDENTS PER YEAR OF STUDY

<i>YEAR OF STUDY</i>	<i>CHIROPRACTIC</i>	<i>HOMOEOPATHY</i>
First year	66	55
Second year	55	42
Third year	46	39

Table 4 indicates that, on average, the chiropractic students were more successful than the homoeopathy students at the end of each of the first three years of study. However, the percentage successful students for both groups was very low with, on

average, only 46% of chiropractic and 39% of the homoeopathy students completing their third year of study at the same time as their peers.

Table 4 indicates that the first year of study was a very dangerous time with on average only 66% of the chiropractic and 55% of the homoeopathy students passing all their subjects at the end of the year. In order to indicate yearly fluctuations in pass rates as well as to compare the percentage successful students in the two programmes, the percentage successful freshmen per year of intake was then displayed in graph form.

FIGURE 5

PERCENTAGE SUCCESSFUL FRESHMEN PER YEAR OF INTAKE

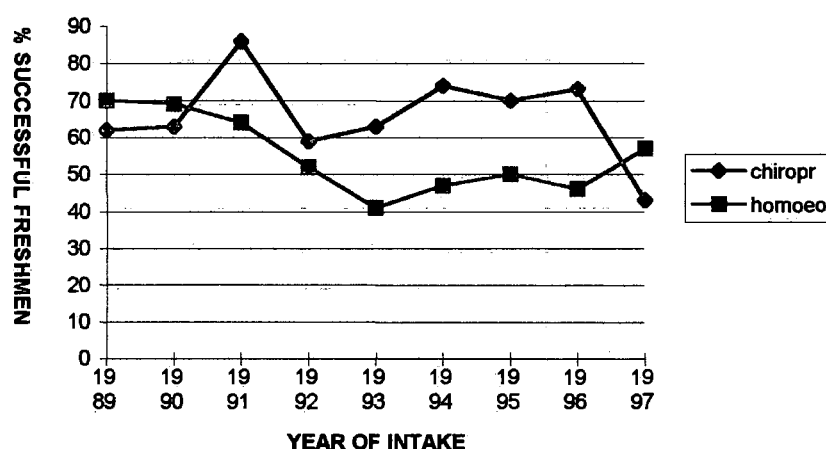


Figure 5 shows a consistently higher percentage of successful freshmen for the Department of Chiropractic than for the Department of Homoeopathy for the period 1991 to 1997.

As Table 4 and Figure 5 indicate such a low percentage of students who were successful at the end of each of the three years of study under investigation, the question has to be asked as to what had happened to the rest. Of serious importance to a tertiary institution is the percentage of students lost to the system, i.e. all the students who are academic exclusions and voluntary withdrawals. In order to investigate the seriousness of this loss, the percentages of all chiropractic and

homoeopathy students who were categorised into these two groups at the end of the first year and by the end of the third year of study were calculated for the period 1989 to 1997 and then averaged.

TABLE 5
AVERAGE PERCENTAGE OF STUDENTS "LOST" FROM THE
PROGRAMMES

	<i>CHIROPRACTIC</i>	<i>HOMOEOPATHY</i>
TOTAL		
At end of 1 st year	23	27
By end of 3 rd year	35	43
ACADEMIC EXCLUSIONS		
At end of 1 st year	17	19
By end of 3 rd year	23	23
VOLUNTARY WITHDRAWALS		
At end of 1 st year	6	8
By end of 3 rd year	12	19

Table 5 indicates the average percentages of students who were "lost" to the system. These are those students who became either academic exclusions (coded as 3) or who withdrew voluntarily (coded as 4). It becomes apparent that the "losses" from homoeopathy were consistently larger than those from chiropractic. Although there was not a large difference between the two groups as far as losses due to academic exclusions were concerned, a definite difference emerged in the average percentages of students who became voluntary withdrawals. Whilst the average voluntary withdrawals during the first year from the homoeopathy programme (8%) was only slightly higher than those from the chiropractic first year (6%), this difference became considerably larger by the end of the third year (19% for homoeopathy as compared to 12% for the chiropractic group).

In any attempt at the management of attrition in the post-registration phase, it is important to know how many students could possibly be saved by remedial/support measures. In order to quantify this group of at risk students in the chiropractic and homoeopathy programmes, the percentage of dropback plus academic exclusion students at the end of each year was calculated for the period 1989 to 1997 and then averaged.

TABLE 6
AVERAGE PERCENTAGE AT RISK STUDENTS

	<i>CHIROPRACTIC</i>	<i>HOMOEOPATHY</i>
At end of 1 st year	28	37
By end of 3 rd year	37	37

Table 6 indicates that, on average over the years investigated, more homoeopathy (37%) than chiropractic (28%) freshmen were experiencing academic difficulties (all those students who became drop-backs (coded as 2) or academic exclusions (coded as 3)). By the end of the third year of studies, however, the average figure of at risk students was the same for the two groups.

The data given above indicate that an unsatisfactory percentage of both chiropractic and homoeopathy students still became academic exclusions and voluntary withdrawals in the second and third years of study. In an attempt to further investigate this phenomenon, those students who had borderline academic performance in their first year of study (became dropbacks) were followed progressively forward over the next two years of study. The percentages of these students who became dropbacks, academic exclusions, or voluntary withdrawals in their second and/or third years of study were calculated for the period 1989 to 1997 and then averaged.

TABLE 7

THE ACADEMIC OUTCOME IN THE SECOND AND THIRD YEARS OF STUDENTS WHO BECAME DROPBACKS IN THEIR FIRST YEAR OF STUDY

<i>DROP-BACKS IN FIRST YEAR</i>	<i>FUTURE DROPBACKS (%)</i>	<i>FUTURE ACADEMIC EXCLUSIONS (%)</i>	<i>FUTURE VOLUNTARY WITHDRAWALS (%)</i>
Chiropractic	44	37	19
Homoeopathy	51	19	30
Total	48	26	26

Table 7 indicates that an average of only 48% (44% chiropractic and 51% homoeopathy) of the students who became dropbacks in the first year of study was still in the system by the beginning of the fourth year of study. The other 52% was "lost" as academic exclusions (26%) and voluntary withdrawals (26%). Of the students that were "lost" to the system, chiropractic had a larger percentage of academic exclusions (37%) and homoeopathy a larger percentage of voluntary withdrawals (30%).

5.1.1 CONCLUSION

This descriptive study indicated clearly that the problem of attrition from both the chiropractic and homoeopathy programmes were unacceptably high and that the biggest problem existed in the first year of study. In an attempt to manage this problem of freshman attrition the utilisation of Test 1 results in the development of an early warning system will now be investigated.

5.2 STUDY 2 : TEST 1 RESULTS

Whilst a strong feeling apparently exists that first test results, or any other early form of assessment in the freshman year, are good indicators of later success, no study could be found that had clearly demonstrated the existence of such a relationship. In this study an attempt was thus made to investigate whether a relationship could be demonstrated between first test results and categorization as successful, dropback, academic exclusion, or voluntary withdrawal at the end of the first year of studies in chiropractic and homoeopathy.

5.2.1 IS THERE A RELATIONSHIP BETWEEN RESULTS OBTAINED IN THE FIRST TESTS AND SUCCESS OR FAILURE AT THE END OF THE FIRST YEAR OF STUDIES?

For each scoring bracket (e.g. 50-59%) obtained in the first physiology test, the academic outcome of all freshmen who had obtained such a score over the period 1989 to 1997 was calculated. When displayed in Table form, the data indicated exactly what percentage of all students who had performed at a certain level in this test had been successful (coded as 1), or had had serious academic difficulties in that they became a dropback (coded as 2) or an academic exclusion (coded as 3) at the end of the freshman year. At the same time it could also indicate for every level of performance in the first physiology test what percentage of the students would remain in the system at the end of the year (successful students plus dropbacks) or what percentage would be at risk (dropbacks plus voluntary withdrawals).

TABLE 8**PHYSIOLOGY TEST 1 – STUDENTS PER CATEGORY**

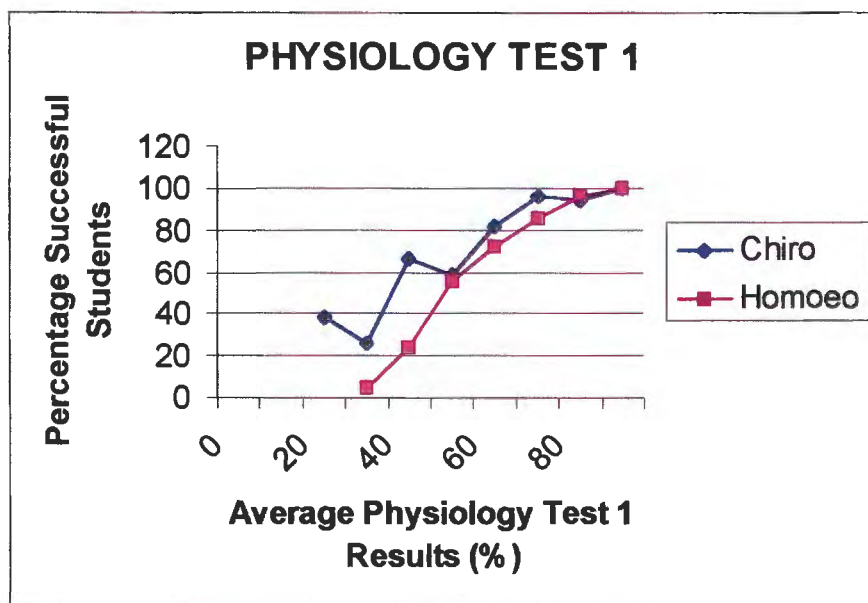
	CHIROPRACTIC	HOMOEOPATHY
Students with < 9%	1 - 2 - 3 - Total 0	1 - 2 - 3 - Total 0
Students with 10-19%	1 -) 2 -) 0% 3 1 100%) 100% Total 1	1 -) 2 1 50%)) 50% 3 1 50%) 100% Total 2 (1%)
Students with 20-29%	1 3 38%) 2 -) 38% 3 5 62%) 62% Total 8 (3%)	1 -) 2 2 29%)) 29% 3 5 71%) 100% Total 7 (3%)
Students with 30-39%	1 6 26%) 2 4 17%)) 43% 3 13 57%) 74% Total 23 (9%)	1 1 5%) 2 7 33%)) 38% 3 13 62%) 95% Total 21 (9%)
Students with 40-49%	1 33 66%) 2 2 4%)) 70% 3 15 30%) 34% Total 50 (20%)	1 9 24%) 2 11 30%)) 54% 3 17 46%) 76% Total 37 (15%)
Students with 50-59%	1 39 59%) 2 17 26%)) 85% 3 10 15%) 41% Total 66 (27%)	1 25 56%) 2 9 20%)) 76% 3 11 24%) 44% Total 45 (18%)
Students with 60-69%	1 42 82%) 2 7 14%)) 96% 3 2 4%) 18% Total 51 (21%)	1 37 72%) 2 12 24%)) 96% 3 2 4%) 28% Total 51 (21%)
Students with 70-79%	1 26 96%) 2 -)) 96% 3 1 4%) 4% Total 27 (11%)	1 44 85%) 2 6 11%)) 96% 3 2 4%) 15% Total 52 (21%)
Students with 80-89%	1 16 94%) 2 -)) 94% 3 1 6%) 6% Total 17 (7%)	1 24 96%) 2 1 4%)) 100% 3 -) 4% Total 25 (10%)
Students with > 90%	1 3 100%) 2 -)) 100% 3 -) 0% Total 3 (1%)	1 5 100%) 2 -)) 100% 3 -) 0% Total 5 (2%)

Table 8 indicates a clear pattern between the scores obtained in the first physiology test and success and retention at the end of the first year of studies. The higher the results obtained in the first physiology test, the higher the percentage of freshmen in both programmes who were successful at the end of the year. On the other hand, of all the students who scored below 40% in this test, the majority became academic exclusions.

In order to demonstrate the trends that became apparent from the data in Table 8, four graphs were constructed, each illustrating a specific aspect of attrition that is important from an institutional point of view. The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the first physiology test and the percentage of successful freshmen per performance category.

FIGURE 6

PERCENTAGE SUCCESSFUL FRESHMEN PER AVERAGE PHYSIOLOGY TEST 1 RESULTS

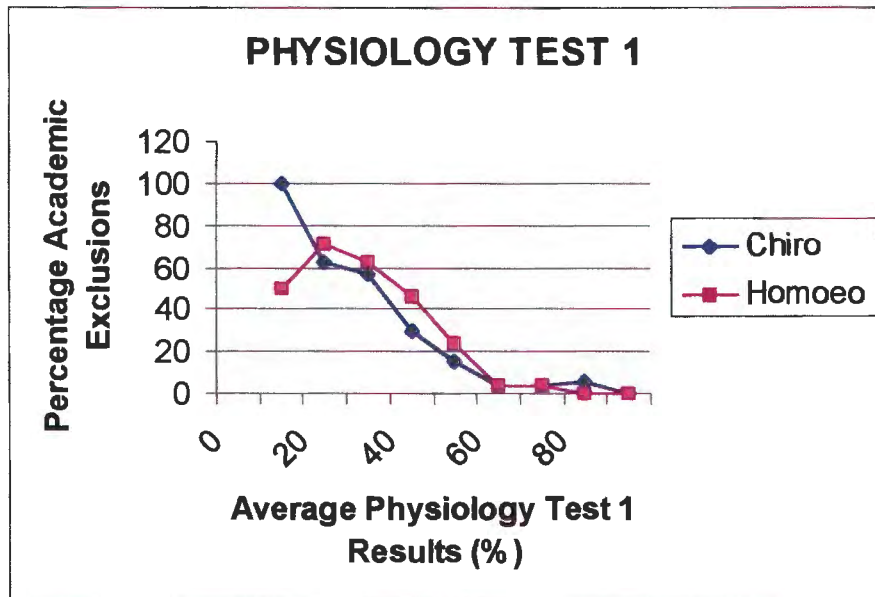


From Figure 6 there seems to be a relationship between performance in the first physiology test and success (students coded as 1) at the end of the first year of studies. Students who had scored high marks in this test ($> 70\%$) had a very good success rate, i.e. 96% for chiropractic students and 85% for homoeopathy students. Of all the students with scores below 80% in this test, it appeared as though the chiropractic students had a better success rate than the homoeopathy students.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the first physiology test and the percentage of academic exclusions per performance category.

FIGURE 7

PERCENTAGE FRESHMEN WHO BECAME ACADEMIC EXCLUSIONS PER AVERAGE PHYSIOLOGY TEST 1 RESULTS



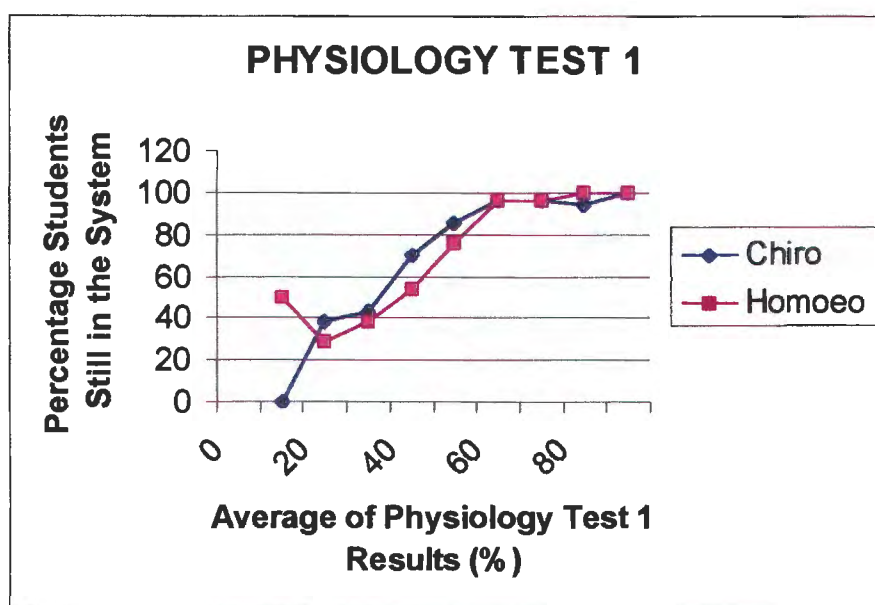
From Figure 7 there seems to be a relationship between performance in the first physiology test and students who had to discontinue their studies because of academic

exclusion at the end of the first year (students coded as 3). Of all the students in the lower scoring brackets (20%-60%), it appeared as though the chiropractic students had a lower academic exclusion rate than the homoeopathy students.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the first physiology test and the percentage of students who remained in the system (successful students plus dropbacks).

FIGURE 8

**PERCENTAGE FRESHMEN WHO REMAINED IN THE SYSTEM PER
AVERAGE PHYSIOLOGY 1 TEST RESULTS**



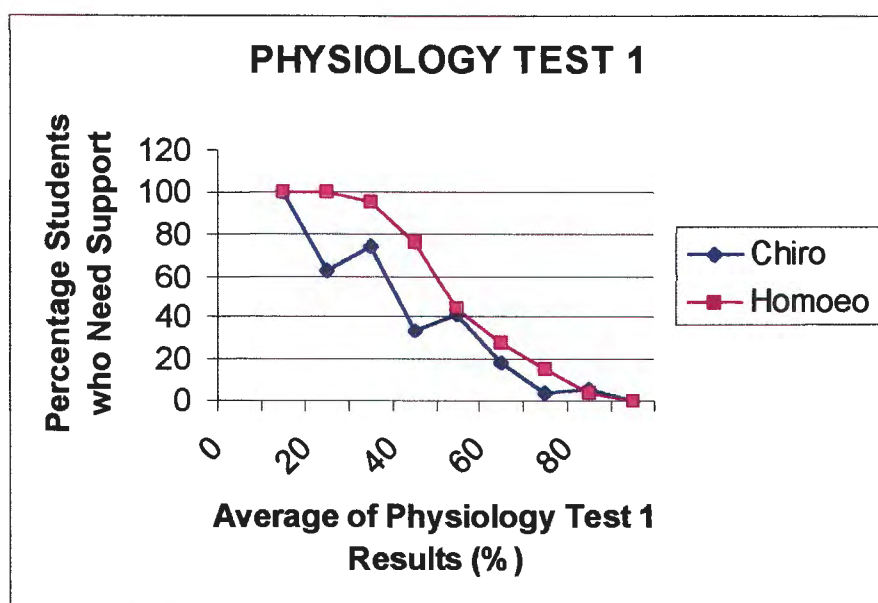
From Figure 8 there seems to be a relationship between performance in the first physiology test and student retention at the end of the first year (students coded as 1 and 2). The two programmes showed a very similar graph for students who had scored above 60%, as they both achieved a 96% retention rate. The graph indicates that the retention

rate for students who had scored between 20% and 60% was slightly better for the chiropractic students than for the homoeopathy students.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the first physiology test and the percentage of students who would require support in order to become successful at the end of the year (dropbacks plus academic exclusions).

FIGURE 9

**PERCENTAGE FRESHMEN WHO WOULD REQUIRE SUPPORT PER
AVERAGE PHYSIOLOGY TEST 1 RESULTS**



From Figure 9 there seems to be a relationship between performance in the first physiology test and students who would need support during the first year of studies, i.e. those students coded as 2 (dropbacks) and as 3 (academic exclusions). Of the students who had scored above 70% in the first physiology test, only 4% of the chiropractic students and 15% of the homoeopathy students would need support. However, for all

students with scores lower than 70%, some form of support would be required. The graph indicates that for all levels of performance in the first physiology test, fewer chiropractic than homoeopathy students needed support in order to become successful, i.e. fewer students became dropbacks or academic exclusions.

A possible relationship between performance in the first anatomy test and academic outcome at the end of the freshman year was also investigated. For each scoring bracket (e.g. 50-59%) obtained in the first anatomy test, the academic outcome of all freshmen who had obtained such a score over the period 1989 to 1997 was calculated. When displayed in Table form, the data could indicate exactly what percentage of all students who had performed at a certain level in this test had been successful (coded as 1), or had had serious academic difficulties in that they became a dropback (coded as 2) or an academic exclusion (coded as 3) at the end of the freshmen year. At the same time it could also indicate for every level of performance in the first anatomy test what percentage of the students would remain in the system at the end of the year (successful students plus dropbacks) or what percentage would be at risk (dropbacks plus voluntary withdrawals).

TABLE 9**ANATOMY TEST 1 – STUDENTS PER CATEGORY**

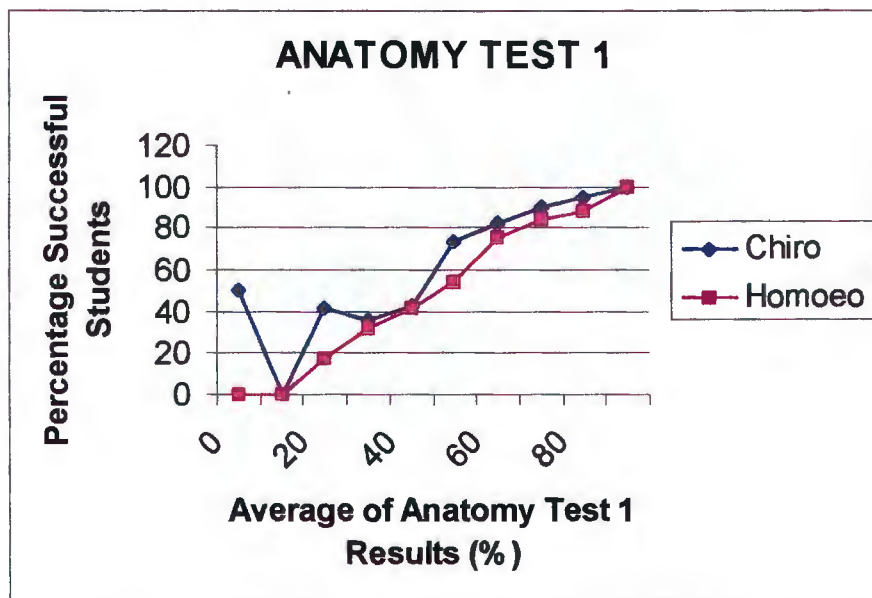
	CHIROPRACTIC	HOMOEOPATHY
Students with < 9%	1 1 50%) 2 -)) 50% 3 1 50%) 50% Total 2 (1%)	1 -) 2 -)) 0% 3 1 100%) 100% Total 1
Students with 10-19%	1 -) 2 -)) 0% 3 1 100%) 100% Total 1	1 -) 2 1 17%)) 17% 3 5 83%) 100% Total 6 (2%)
Students with 20-29%	1 5 42%) 2 1 8%)) 50% 3 6 50%) 59% Total 12 (4%)	1 2 17%) 2 3 25%)) 42% 3 7 58%) 83% Total 12 (5%)
Students with 30-39%	1 9 36%) 2 5 20%)) 56% 3 11 44%) 64% Total 25 (95)	1 6 32%) 2 7 36%)) 68% 3 6 32%) 68% Total 19 (8%)
Students with 40-49%	1 19 43%) 2 11 25%)) 68% 3 14 32%) 57% Total 44 (16%)	1 16 42%) 2 10 26%)) 68% 3 12 32%) 58% Total 38 (15%)
Students with 50-59%	1 45 74%) 2 5 8%)) 82% 3 11 18%) 26% Total 61 (22%)	1 28 54%) 2 13 25%)) 79% 3 11 21%) 46% Total 52 (20%)
Students with 60-69%	1 54 82%) 2 7 11%)) 93% 3 5 7%) 18% Total 66 (23%)	1 42 75%) 2 9 16%)) 91% 3 5 9%) 25% Total 56 (22%)
Students with 70-79%	1 43 90%) 2 3 6%)) 96% 3 2 4%) 10% Total 48 (17%)	1 36 84%) 2 4 9%)) 93% 3 3 7%) 16% Total 43 (17%)
Students with 80-89%	1 20 95%) 2 1 5%)) 100% 3 -) 5% Total 21 (7%)	1 21 88%) 2 2 8%)) 96% 3 1 4%) 12% Total 24 (9%)
Students with > 90%	1 1 100%) 2 -)) 100% 3 -) 0% Total 1	1 3 100%) 2 -)) 100% 3 -) 0% Total 3 (1%)

Table 9 indicates a clear pattern between the scores obtained in the first anatomy test and success and retention at the end of the first year of studies. The higher the results obtained in the first anatomy test, the higher the percentage of freshmen in both programmes who were successful at the end of the year.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the first anatomy test and the percentage of successful freshmen per performance category.

FIGURE 10

PERCENTAGE SUCCESSFUL FRESHMEN PER AVERAGE ANATOMY TEST 1 RESULTS



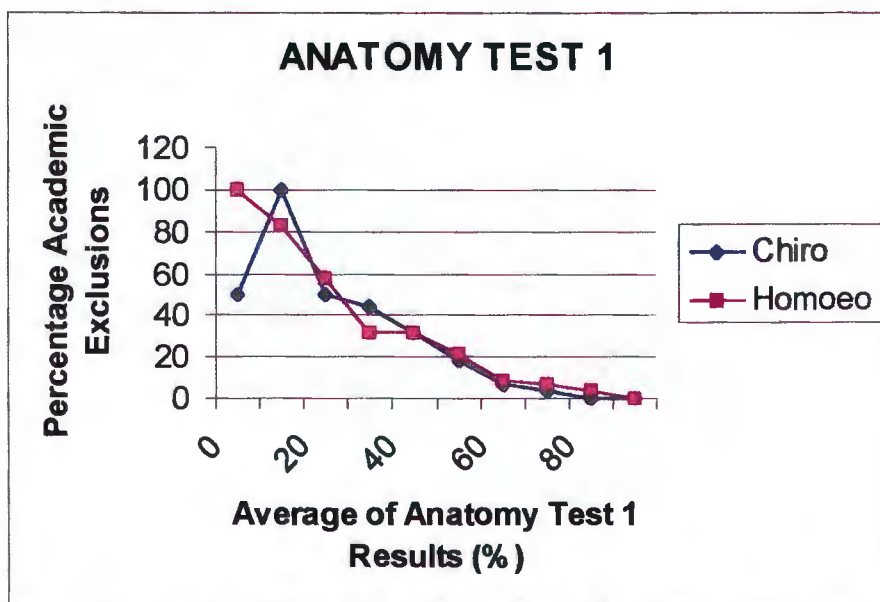
From Figure 10 there seems to be a relationship between performance in the first anatomy test and success (students coded as 1) at the end of the first year of studies.

Students who had scored high marks in this test ($< 70\%$) had a good success rate. Of all scores obtained in the first anatomy test, it appears as though the chiropractic students had a better success rate than the homoeopathy students.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the first anatomy test and the percentage of academic exclusions per performance category.

FIGURE 11

PERCENTAGE FRESHMEN WHO BECAME ACADEMIC EXCLUSIONS PER AVERAGE ANATOMY TEST 1 RESULTS

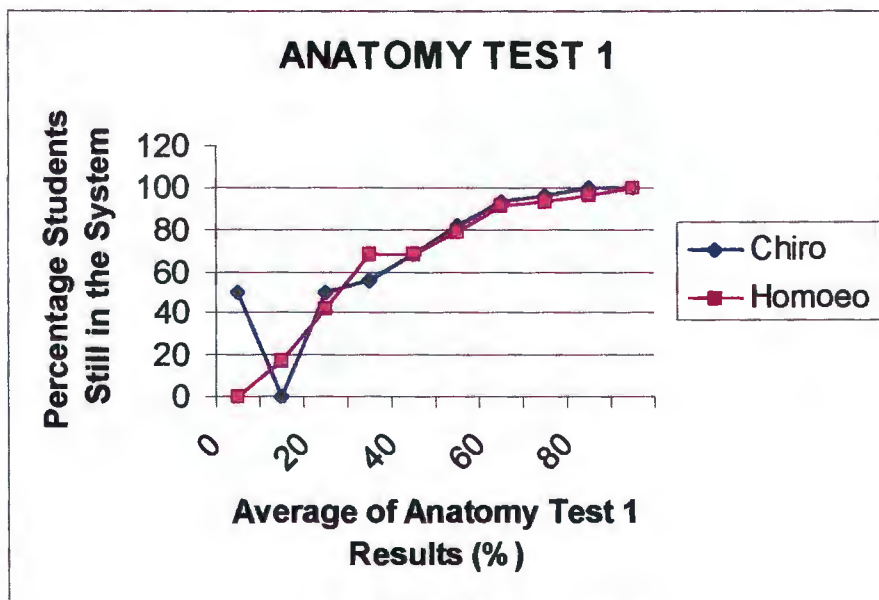


From Figure 11 there seems to be a clear relationship between performance in the first anatomy test and students who had to discontinue their studies because of academic exclusion at the end of the first year (students coded as 3). The two programmes had a very similar graph with only the group of students who had scored above 90% on average not having any member facing academic exclusion at the end of the first year.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the first anatomy test and the percentage of students who remained in the system (successful students plus dropbacks).

FIGURE 12

**PERCENTAGE FRESHMEN WHO REMAINED IN THE SYSTEM PER
AVERAGE ANATOMY TEST 1 RESULTS**

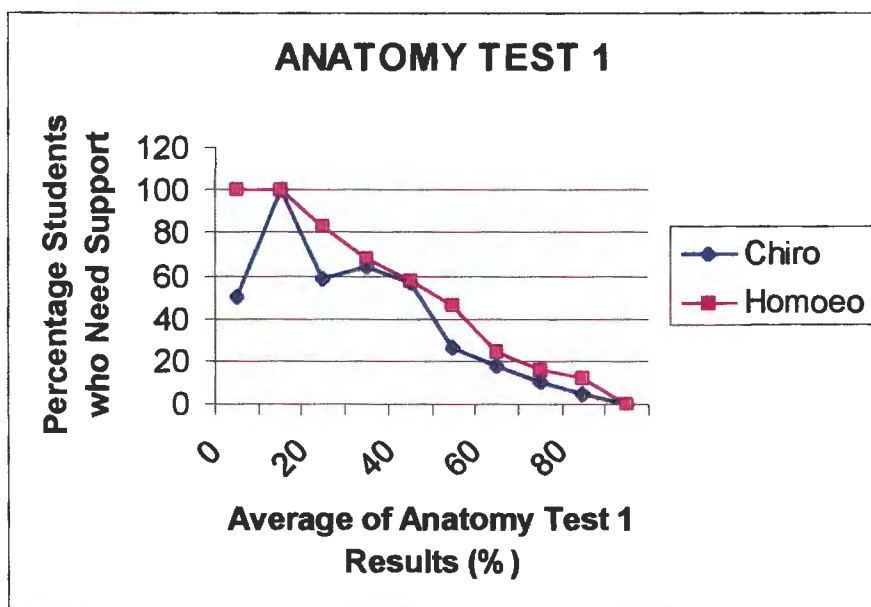


From Figure 12 there seems to be a relationship between performance in the first anatomy test and student retention at the end of the first year (students coded as 1 and 2). The two programmes showed a very similar graph, with students who had scored above 60% having a >90% retention rate.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the first anatomy test and the percentage of students who would require support in order to become successful at the end of the year (dropbacks plus academic exclusions).

FIGURE 13

**PERCENTAGE FRESHMEN WHO WOULD REQUIRE SUPPORT PER
AVERAGE ANATOMY TEST 1 RESULTS**



From Figure 13 there seems to be a relationship between performance in the first anatomy test and students who would need support during the first year of studies, i.e. those students coded as 2 (dropbacks) and as 3 (academic exclusions). For both programmes, only those students who had scored above 90% in the first anatomy test appeared not to require any academic support. For all students with scores <90%, some form of support is indicated. The graph indicates that for all levels of performance in the first anatomy test, fewer chiropractic than homoeopathy students needed support in order to become successful, i.e. fewer students became dropbacks or academic exclusions.

A possible relationship between performance in the first biology test and academic outcome at the end of the freshman year was also investigated. For each scoring bracket (e.g. 50-59%) obtained in the first biology test, the academic outcome of all freshmen who had obtained such a score over the period 1989 to 1997 was calculated. When displayed in Table form, the data could indicate exactly what percentage of all students who had performed at a certain level in this test had been successful (coded as 1), or had had serious academic difficulties in that they became a dropback (coded as 2) or an academic exclusion (coded as 3) at the end of the freshmen year. At the same time it could also indicate for every level of performance in the first biology test what percentage of the students would remain in the system at the end of the year (successful students plus dropbacks) or what percentage would be at risk (dropbacks plus voluntary withdrawals).

TABLE 10**BIOLOGY TEST 1 – STUDENTS PER CATEGORY**

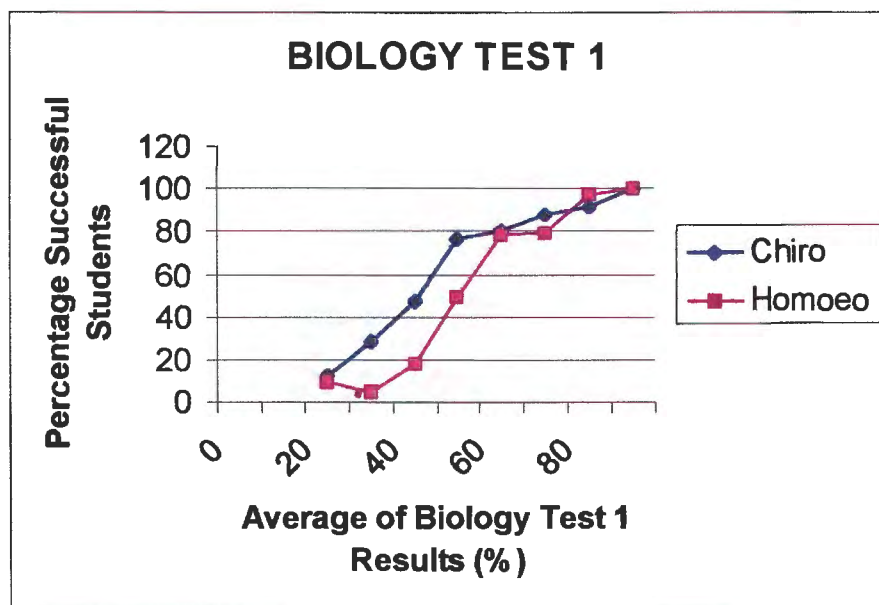
	CHIROPRACTIC	HOMOEOPATHY
Students with < 9%	1 - 2 - 3 - Total 0	1 - 2 - 3 - Total 0
Students with 10-19%	1 - 2 - 3 - Total 0	1 -) 2 -) 0% 3 1 100%) 100% Total 1
Students with 20-29%	1 1 12%) 2 -) 12% 3 7 88%) 88% Total 8 (3%)	1 1 9%) 2 1 9%) 18% 3 9 82%) 91% Total 11 (5%)
Students with 30-39%	1 7 28%) 2 5 20%) 48% 3 13 52%) 72% Total 25 (10%)	1 1 5%) 2 6 27%) 32% 3 15 68%) 95% Total 22 (9%)
Students with 40-49%	1 18 47%) 2 12 32%) 79% 3 8 21%) 53% Total 38 (15%)	1 5 18%) 2 11 41%) 59% 3 11 41%) 82% Total 27 (11%)
Students with 50-59%	1 44 77%) 2 5 9%) 86% 3 8 14%) 23% Total 57 (22%)	1 19 49%) 2 11 28%) 77% 3 9 23%) 51% Total 39 (17%)
Students with 60-69%	1 52 80%) 2 7 11%) 91% 3 6 9%) 20% Total 65 (25%)	1 46 78%) 2 10 17%) 95% 3 3 5%) 22% Total 59 (25%)
Students with 70-79%	1 43 88%) 2 2 4%) 92% 3 4 8%) 12% Total 49 (19%)	1 35 79%) 2 6 14%) 93% 3 3 7%) 21% Total 44 (19%)
Students with 80-89%	1 11 92%) 2 1 8%) 100% 3 -) 8% Total 12 (5%)	1 32 97%) 2 1 3%) 100% 3 -) 3% Total 33 (14%)
Students with > 90%	1 4 100%) 2 -) 100% 3 -) 0% Total 4 (2%)	1 1 100%) 2 -) 100% 3 -) 0% Total 1

Table 10 indicates a clear pattern between the scores obtained in the first biology test and success and retention at the end of the first year of studies. The higher the results obtained in the first biology test, the higher the percentage of freshmen in both programmes who were successful at the end of the year. On the other hand, of all the students who had scored below 40% in this test, the majority became academic exclusions.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the first biology test and the percentage of successful freshmen per performance category.

FIGURE 14

PERCENTAGE SUCCESSFUL FRESHMEN PER AVERAGE BIOLOGY TEST 1 RESULTS

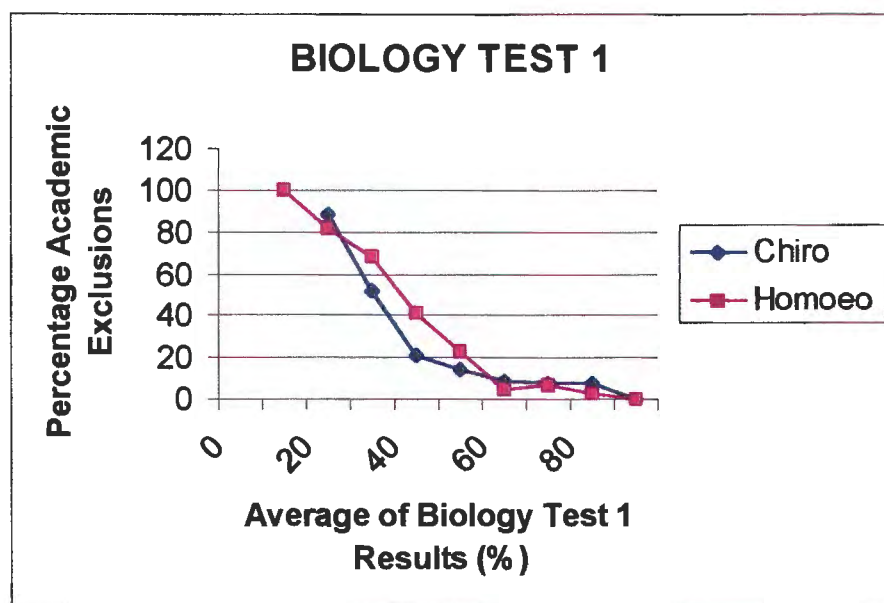


From Figure 14 there seems to be a relationship between performance in the first biology test and success (students coded as 1) at the end of the first year of studies. For both programmes, those students who had scored above 80% in this test had a >90% success rate. Of all the students with scores below 80% in the first biology test, it appears as though the chiropractic students had a better success rate than the homoeopathy students.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the first biology test and the percentage of academic exclusions per performance category.

FIGURE 15

PERCENTAGE FRESHMEN WHO BECAME ACADEMIC EXCLUSIONS PER AVERAGE BIOLOGY TEST 1 RESULTS



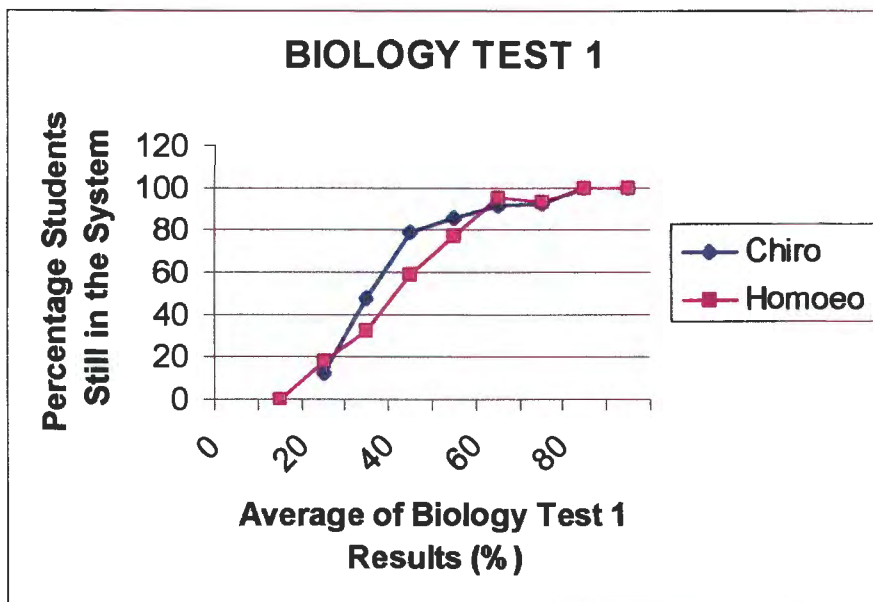
From Figure 15 there seems to be a relationship between performance in the first biology test and students who had to discontinue their studies because of academic exclusion at

the end of the first year (students coded as 3). Only the group of students who had scored above 90% on average had no member facing academic exclusion at the end of the first year. Of the students in the lower scoring brackets (30%-60%), it appeared as though the chiropractic students had a lower academic exclusion rate than the homoeopathy students.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the first biology test and the percentage of students who remained in the system (successful students plus dropbacks).

FIGURE 16

**PERCENTAGE FRESHMEN WHO REMAINED IN THE SYSTEM PER
AVERAGE BIOLOGY TEST 1 RESULTS**



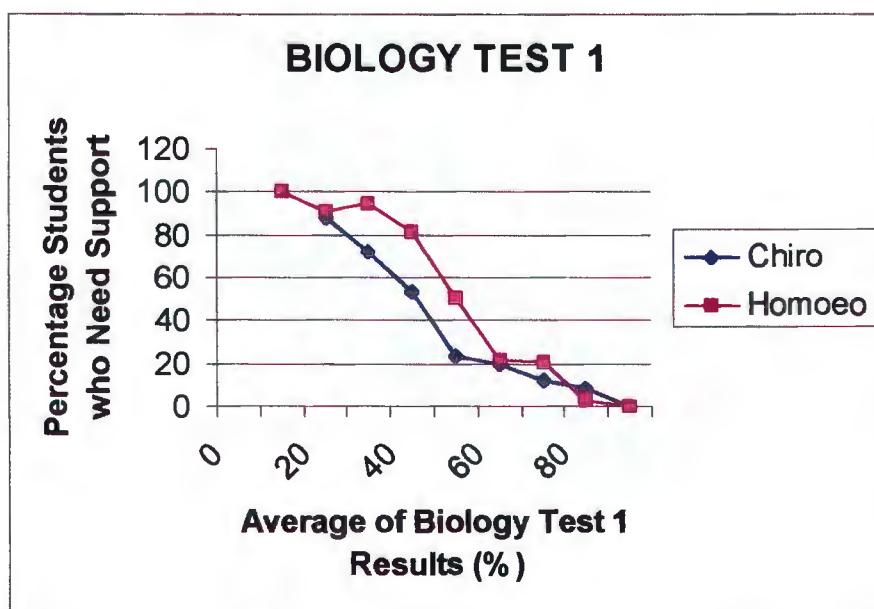
From Figure 16 there seems to be a relationship between performance in the first biology test and student retention at the end of the first year (students coded as 1 and 2). Students

who had scored above 70% in the first biology test had a retention rate of >90%. The graph indicates that the retention rate for students who had scored between 20% and 60% was slightly better for the chiropractic students than for the homoeopathy students.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the first biology test and the percentage of students who would require support in order to become successful at the end of the year (dropbacks plus academic exclusions).

FIGURE 17

**PERCENTAGE FRESHMEN WHO WOULD REQUIRE SUPPORT PER
AVERAGE BIOLOGY TEST 1 RESULTS**



From Figure 17 there seems to be a relationship between performance in the first biology test and students who would need support during the first year of studies, i.e. those students coded as 2 (dropbacks) and as 3 (academic exclusions). Of the students who

had scored above 80% in the first physiology test, only 8% of the chiropractic students and 3% of the homoeopathy students would need support. However, for all students with lower scores, some form of support is required. The graph indicates that for all levels of performance in the first biology test, fewer chiropractic than homoeopathy students needed support in order to become successful, i.e. fewer students became dropbacks or academic exclusions.

A possible relationship between performance in the first chemistry test and academic outcome at the end of the freshman year was also investigated. For each scoring bracket (e.g. 50-59%) obtained in the first chemistry test, the academic outcome of all freshmen who had obtained such a score over the period 1989 to 1997 was calculated. When displayed in Table form, the data could indicate exactly what percentage of all students who had performed at a certain level in this test had been successful (coded as 1), or had had serious academic difficulties in that they became a dropback (coded as 2) or an academic exclusion (coded as 3) at the end of the freshmen year. At the same time it could also indicate for every level of performance in the first chemistry test what percentage of the students would remain in the system at the end of the year (successful students plus dropbacks) or what percentage would be at risk (dropbacks plus voluntary withdrawals).

TABLE 11**CHEMISTRY TEST 1 – STUDENTS PER CATEGORY**

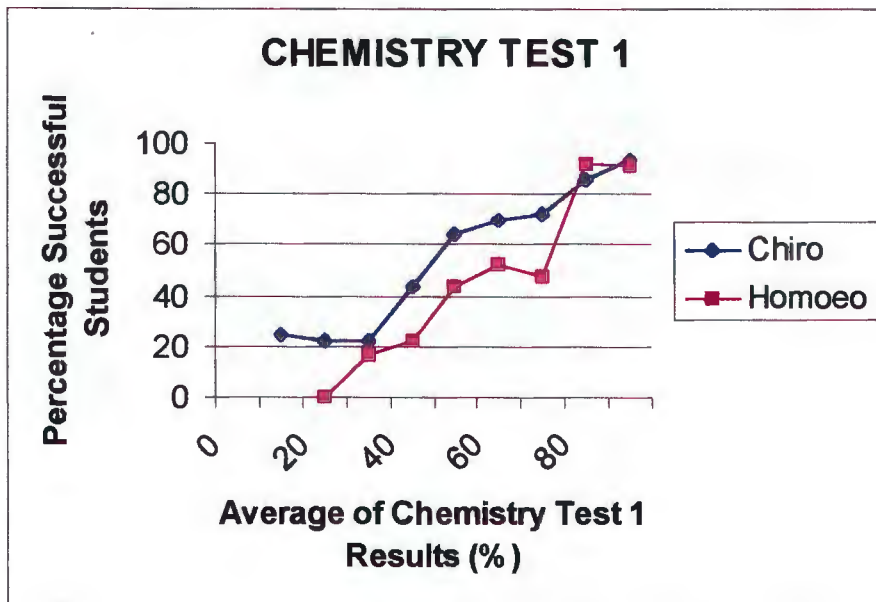
	CHIROPRACTIC	HOMOEOPATHY
Students with < 9%	1 - 2 - 3 - Total 0	1 - 2 - 3 - Total 0
Students with 10-19%	1 1 25%) 2 -)) 25% 3 4 75%) 75% Total 4 (2%)	1 - 2 - 3 - Total 0
Students with 20-29%	1 2 22%) 2 2 22%)) 44% 3 5 56%) 78% Total 9 (4%)	1 -) 2 1 25%)) 25% 3 3 75%) 100% Total 4 (2%)
Students with 30-39%	1 2 22%) 2 2 22%)) 44% 3 5 56%) 78% Total 9 (4%)	1 1 17%) 2 2 33%)) 50% 3 3 50%) 83% Total 6 (3%)
Students with 40-49%	1 8 44%) 2 1 6%)) 50% 3 9 50%) 56% Total 18 (7%)	1 5 22%) 2 3 13%)) 35% 3 15 65%) 78% Total 23 (10%)
Students with 50-59%	1 23 64%) 2 7 17%)) 81% 3 6 19%) 36% Total 36 (14%)	1 18 44%) 2 11 27%)) 71% 3 12 29%) 56% Total 41 (18%)
Students with 60-69%	1 30 70%) 2 7 16%)) 86% 3 6 14%) 30% Total 43 (17%)	1 21 52%) 2 11 28%)) 80% 3 8 20%) 48% Total 40 (18%)
Students with 70-79%	1 38 72%) 2 5 9%)) 81% 3 10 19%) 28% Total 53 (21%)	1 19 48%) 2 16 40%)) 88% 3 5 12%) 52% Total 40 (18%)
Students with 80-89%	1 43 86%) 2 6 12%)) 98% 3 1 2%) 14% Total 50 (20%)	1 36 92%) 2 2 5%)) 97% 3 1 3%) 8% Total 39 (17%)
Students with > 90%	1 20 94%) 2 1 3%)) 97% 3 1 3%) 6% Total 31 (12%)	1 30 91%) 2 1 3%)) 94% 3 2 6%) 0% Total 33 (15%)

Table 11 indicates a clear relationship between the scores obtained in the first chemistry test and success and failure at the end of the first year of studies. The higher the results obtained in the first chemistry test, the higher the percentage of freshmen in both programmes who were successful at the end of the year. On the other hand, of all the students who had scored below 50% in this test, the majority became academic exclusions.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the first chemistry test and the percentage of successful freshmen per performance category.

FIGURE 18

PERCENTAGE SUCCESSFUL FRESHMEN PER AVERAGE CHEMISTRY TEST 1 RESULTS

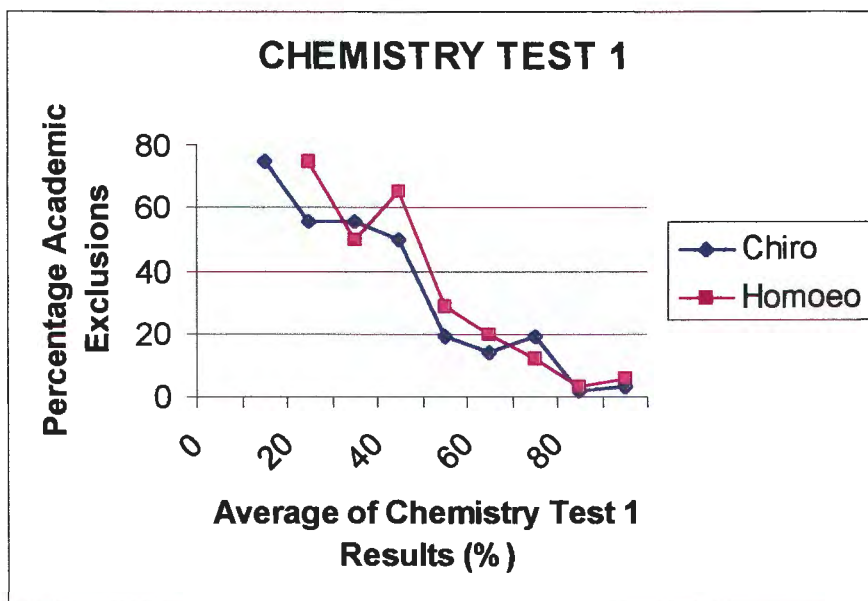


From Figure 18 there seems to be a relationship between performance in the first chemistry test and success (students coded as 1) at the end of the first year of studies. For both programmes, those students who had scored above 80% in this test had a > 90% success rate at the end of the year. Of all the students with scores below 80% in the first chemistry test, it appears as though the chiropractic students had a better success rate than the homoeopathy students.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homeopathy freshmen in the first chemistry test and the percentage of academic exclusions per performance category.

FIGURE 19

PERCENTAGE FRESHMEN WHO BECAME ACADEMIC EXCLUSIONS PER AVERAGE CHEMISTRY TEST 1 RESULTS



From Figure 19 there seems to be a relationship between performance in the first chemistry test and students who had to discontinue their studies because of academic

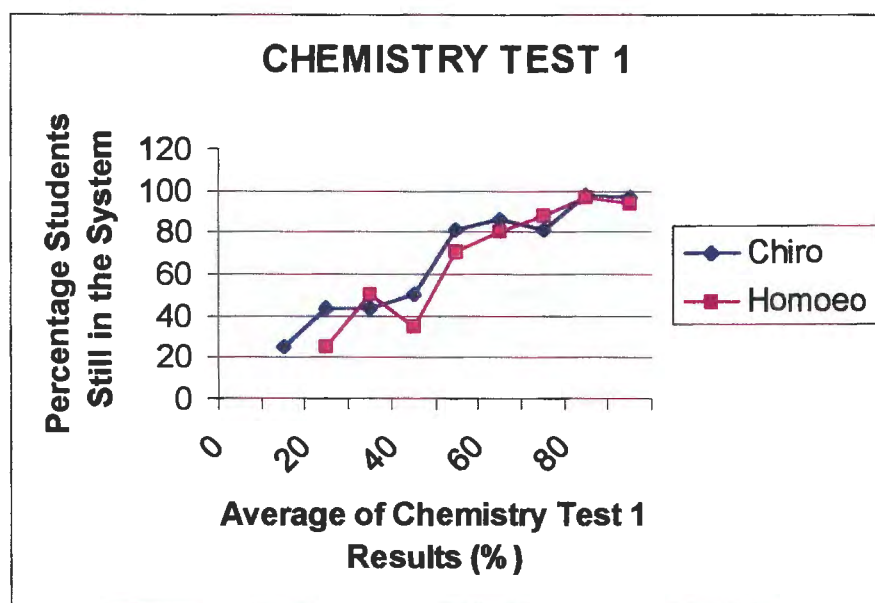
exclusion at the end of the first year (students coded as 3). Of those students who had scored above 90% in the first chemistry test, 6% of the homoeopathy students and 3% of the chiropractic students still became academic exclusions at the end of the first year.

The two programmes had a very similar average loss due to academic exclusion relative to scores obtained in the first chemistry tests, with the chiropractic students appearing to have slightly lower rates than the homoeopathy students.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the first chemistry test and the percentage of students who remained in the system (successful students plus dropbacks).

FIGURE 20

**PERCENTAGE FRESHMEN WHO REMAINED IN THE SYSTEM PER
AVERAGE CHEMISTRY TEST 1 RESULTS**

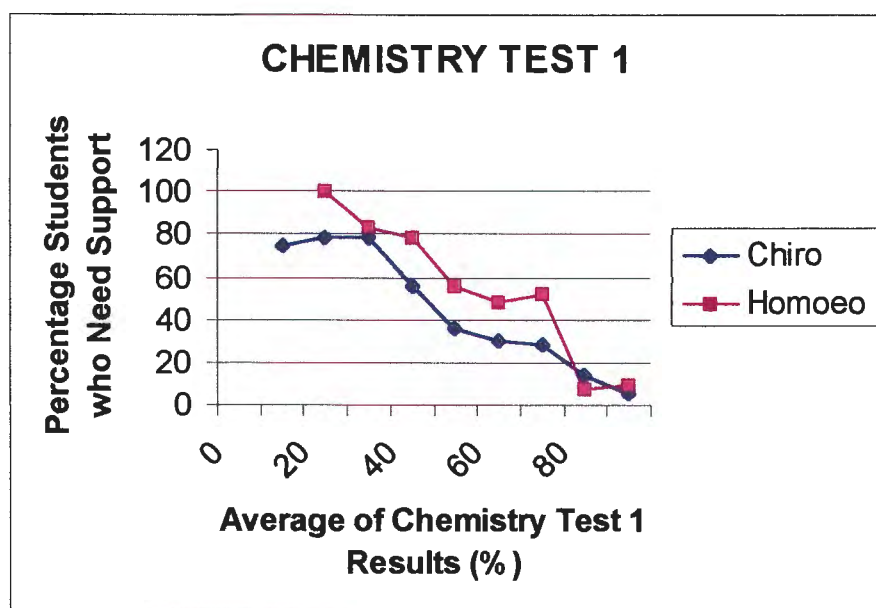


From Figure 20 there seems to be a strong relationship between performance in the first chemistry test and student retention at the end of the first year (students coded as 1 and 2). Students who had scored above 80% in the first year had a retention rate of >90%. The two programmes had a very similar retention rate relative to scores obtained in the first chemistry tests.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the first chemistry test and the percentage of students who would require support in order to become successful at the end of the year (dropbacks plus academic exclusions).

FIGURE 21

**PERCENTAGE FRESHMEN WHO WOULD REQUIRE SUPPORT PER
AVERAGE CHEMISTRY TEST 1 RESULTS**



From Figure 21 there seems to be a relationship between performance in the first chemistry test and students who would need support during the first year of studies, i.e.

those students coded as 2 (dropbacks) and 3 (academic exclusions). Of the students who had scored above 90% in the first chemistry test, 6% of the chiropractic students and 9% of the homoeopathy students would still require some academic support. The graph indicates that for all levels of performance in the first chemistry test, fewer chiropractic than homoeopathy students needed support to become successful, i.e. fewer students became dropbacks or academic exclusions.

A possible relationship between performance in the first physics test and academic outcome at the end of the freshman year was also investigated. For each scoring bracket (e.g. 50-59%) obtained in the first physics test, the academic outcome of all freshmen who had obtained such a score over the period 1989 to 1997 was calculated. When displayed in Table form, the data could indicate exactly what percentage of all students who had performed at a certain level in this test had been successful (coded as 1), or had had serious academic difficulties in that they became a dropback (coded as 2) or an academic exclusion (coded as 3) at the end of the freshmen year. At the same time it could also indicate for every level of performance in the first physics test what percentage of the students would remain in the system at the end of the year (successful students plus dropbacks) or what percentage would be at risk (dropbacks plus voluntary withdrawals).

TABLE 12**PHYSICS TEST 1 – STUDENTS PER CATEGORY**

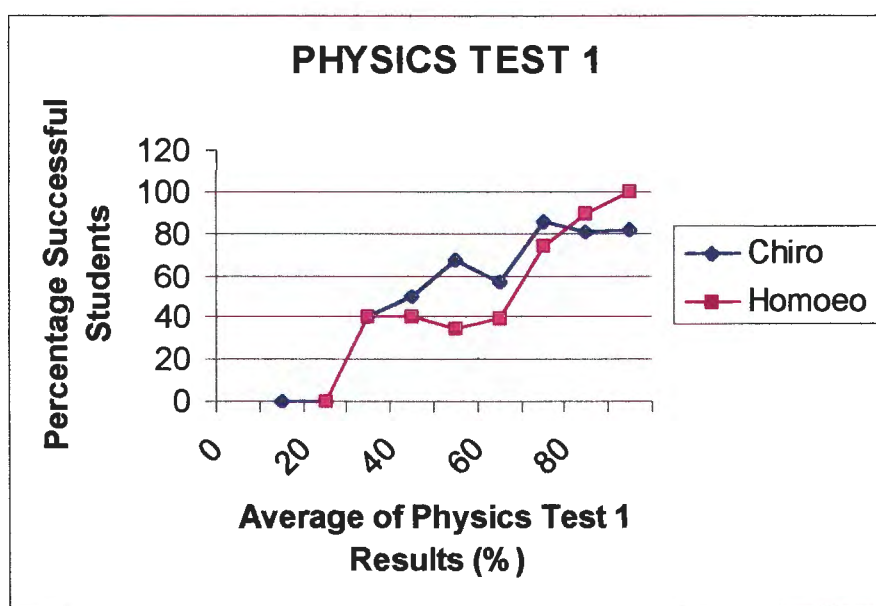
	CHIROPRACTIC	HOMOEOPATHY
Students with < 9%	1 - 2 - 3 - Total 0	1 - 2 - 3 - Total 0
Students with 10-19%	1 -) 2 -) 0% 3 1 100%) 100% Total 1	1 - 2 - 3 - Total 0
Students with 20-29%	1 -) 2 -) 0% 3 2 100%) 100% Total 2 (1%)	1 -) 2 -) 0% 3 1 100%) 100% Total 1
Students with 30-39%	1 2 40%) 2 -) 40% 3 3 60%) 60% Total 5 (2%)	1 2 40%) 2 2 40%) 80% 3 1 20%) 60% Total 5 (5%)
Students with 40-49%	1 7 50%) 2 1 7%) 57% 3 6 43%) 50% Total 14 (6%)	1 12 40%) 2 3 10%) 50% 3 15 50%) 60% Total 30 (13%)
Students with 50-59%	1 28 67%) 2 4 9%) 76% 3 10 24%) 33% Total 42 (17%)	1 10 35%) 2 5 17%) 52% 3 14 48%) 65% Total 29 (13%)
Students with 60-69%	1 32 57%) 2 11 20%) 77% 3 13 23%) 43% Total 56 (23%)	1 24 39%) 2 25 41%) 80% 3 12 20%) 61% Total 61 (27%)
Students with 70-79%	1 50 85%) 2 5 8%) 93% 3 4 7%) 15% Total 59 (24%)	1 37 74%) 2 9 18%) 92% 3 4 8%) 26% Total 50 (22%)
Students with 80-89%	1 42 81%) 2 6 11%) 92% 3 4 8%) 19% Total 52 (22%)	1 42 89%) 2 2 4%) 93% 3 3 7%) 11% Total 47 (20%)
Students with > 90%	1 9 82%) 2 1 9%) 91% 3 1 9%) 18% Total 11 (5%)	1 7 100%) 2 -) 100% 3 -) 0% Total 7 (3%)

Table 12 indicates some relationship between the scores obtained in the first physics test and success and failure at the end of the first year of studies. The relationship does not appear to be as linear as that shown with the other first test results. For example of the chiropractic students who had scored $> 90\%$ in this test, only 82% were successful at the end of the year. The same trend is apparent for the homoeopathy students.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the first physics test and the percentage of successful freshmen per performance category.

FIGURE 22

PERCENTAGE SUCCESSFUL FRESHMEN PER AVERAGE PHYSICS TEST 1 RESULTS

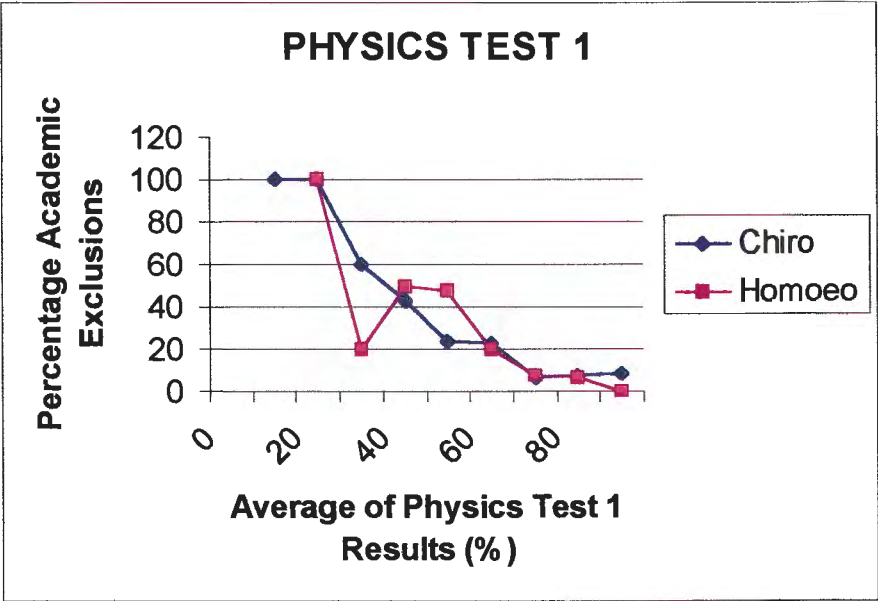


From Figure 22 there seems to be some relationship between performance in the first physics test and success (students coded as 1) at the end of the first year of studies. It is

apparent that high scores in the first physics test did not ensure academic success at the end of the first year. Over all the years investigated, only 7 homoeopathy students who had scored above 90% in the first test successfully completed the first year. Of all the students with physics first test results between 40% and 80%, it appeared as though the chiropractic students had a better success rate than the homoeopathy students.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the first physics test and the percentage of academic exclusions per performance category.

FIGURE 23
PERCENTAGE FRESHMEN WHO BECAME ACADEMIC EXCLUSIONS PER AVERAGE PHYSICS TEST 1 RESULTS

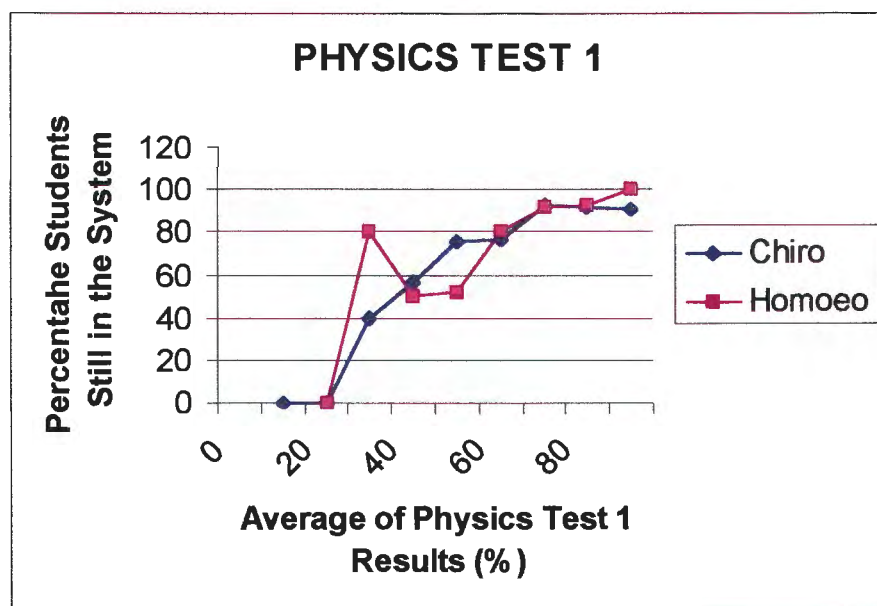


From Figure 23 there seems to be some relationship between performance in the first physics test and students who had to discontinue their studies because of academic exclusion at the end of the first year (students coded as 3). Of those students who had scored above 90% in the first physics test, 9% of the chiropractic students still became academic exclusions at the end of the first year.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the first physics test and the percentage of students who remained in the system (successful students plus dropbacks).

FIGURE 24

**PERCENTAGE FRESHMEN WHO REMAINED IN THE SYSTEM PER
AVERAGE PHYSICS TEST 1 RESULTS**



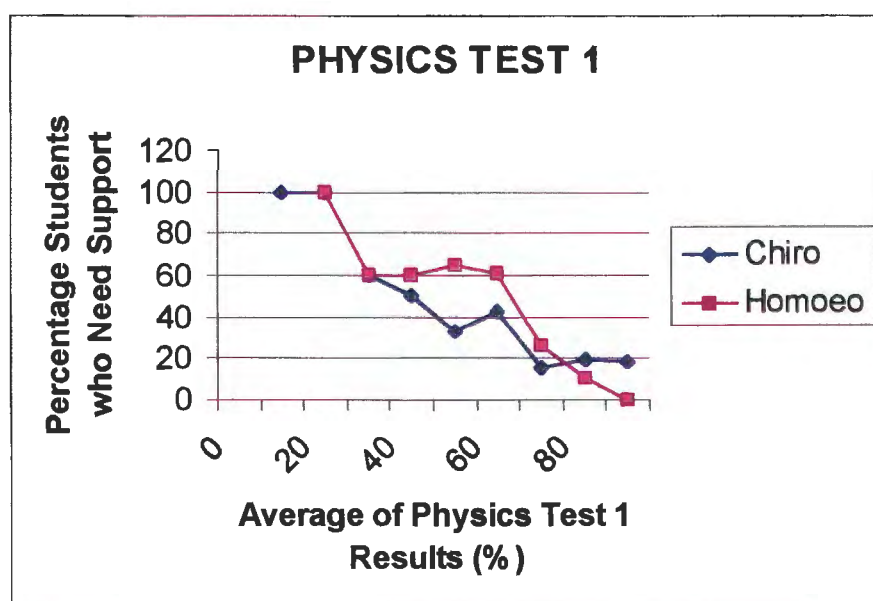
From Figure 24 there seems to be a relationship between performance in the first physics test and student retention at the end of the first year (students coded as 1 and 2). In both

programmes, students who had scored above 70% in this test, had a retention rate of >90%.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the first physics test and the percentage of students who would require support in order to become successful at the end of the year (dropbacks plus academic exclusions).

FIGURE 25

PERCENTAGE FRESHMEN WHO WOULD REQUIRE SUPPORT PER AVERAGE PHYSICS TEST 1 RESULTS



From Figure 25 there seems to be some relationship between performance in the first physics test and students who would need support during the first year of studies, i.e. those students coded as 2 (dropbacks) and 3 (academic exclusions). Except for those homoeopathy students who had scored above 90%, all other students would apparently require some support. The graph indicates that of all students with first test physics

scores below 80%, fewer chiropractic than homoeopathy students would need support in order to become successful, i.e. fewer students become dropbacks or academic exclusions.

5.2.1.1 CONCLUSION

From the results reported in this section there seems to be a relationship between first test results and academic outcome at the end of the freshman year. In the next section an attempt will thus be made to utilize the first test results in the development of an estimated logistic regression model for the early identification of the student in need of support.

5.2.2 CAN A LOGISTIC REGRESSION MODEL THAT WILL IDENTIFY THE FRESHMEN AT RISK OF FAILURE BE ESTIMATED FROM TEST 1 RESULTS?

The purpose of this study was to investigate the predictive relationship between first test results and the probability that a student will require support in order to be successful at the end of the year (the probability that the student fails to succeed). All data between 1989 and 1995 inclusive were used in this analysis.

5.2.2.1 LIST OF VARIABLES

Dichotomous dependent variable:

Y = { 1 if not successful (students coded as 2, 3, 4)
 { 2 if successful (students coded as 1)

Independent variables:

X1 : Physiology Test 1 results
 X2 : Anatomy Test 1 results
 X3 : Biology Test 1 results
 X4 : Chemistry Test 1 results
 X5 : Physics Test 1 results

TABLE 13

PARAMETER ESTIMATES FROM THE OPTIMUM LOGISTIC REGRESSION MODEL USING TEST 1 RESULTS AS PREDICTOR VARIABLES

Variable	$\hat{\beta}$	S.E. ($\hat{\beta}$)	Exp ($\hat{\beta}$)	P-values	95% C.I. for Exp ($\hat{\beta}$)	Order of Strength
Physiol I	0.0538	0.0156	1.0552	0.0006	1.0235 1.0880	1
Anat I	0.0528	0.0108	1.0542	0.0000	1.0320 1.0768	2
Biol I	0.0446	0.0145	1.0456	0.0021	1.0164 1.0757	3
Chem I	0.0352	0.0094	1.0358	0.0002	1.0168 1.0552	4
Constant	-10.6759	1.1798		0.0000		

FIGURE 26

ESTIMATED LOGISTIC REGRESSION MODEL USING TEST 1 RESULTS AS PREDICTOR VARIABLES

From Table 13 the estimated logistic regression model is expressed as shown below:

$$\Pr(Y = 1) = \frac{1}{1 + e^{-Z}}$$

$Z = -10.7 + 0.05(\text{Physiol } 1) + 0.05(\text{Anat } 1) + 0.04(\text{Biol } 1) + 0.04(\text{Chem } 1)$
--

Using the above equation, an estimation can be made of **the probability that Y = 1** (the probability that a student fails to succeed) for any given values of the variables Physiology Test 1 results, Anatomy Test 1 results, Biology Test 1 results, Chemistry Test 1 results, for any specific student enrolled in the Departments of Chiropractic and Homoeopathy at the end of the first year of studies.

5.2.2.2 INTERPRETATIONS OF THE ESTIMATED LOGISTIC REGRESSION MODEL USING TEST 1 RESULTS AS PREDICTOR VARIABLES

Interpretations are given below on the basis of the results reported in Table 13.

The low level of a predictor variable contributes less than its high level to the probability of failure, $\Pr(Y = 1)$.

1. When the “Physiol 1” variable changes from low level to high level (when the score obtained in the first physiology class test decreases from $> 90\%$ to $< 9\%$), the likelihood of a student not being successful at the end of the first year increases by a factor 1.0552. The fact that the odds ratio is greater than 1 shows that the physiology first test result is a strong predictor variable that affects academic success at the end of the first year of studies.
2. When the “Anat 1” variable changes from low level to high level (when the score obtained in the first anatomy class test decreases from $> 90\%$ to $< 9\%$), the likelihood of a student not being successful at the end of the first year increases by a factor 1.0542. The fact that the odds ratio is greater than 1 shows that the anatomy first test result is a strong predictor variable that affects academic success at the end of the first year of studies.
3. When the “Biol 1” variable changes from low level to high level (when the score obtained in the first biology class test decreases from $> 90\%$ to $< 9\%$), the likelihood of a student not being successful at the end of the first year increases by a factor 1.0456. The fact that the odds ratio is greater than 1 shows that the biology first test result is a strong predictor variable that affects academic success at the end of the first year of studies.

4. When the “Chem 1” variable changes from low level to high level (when the score obtained in the first chemistry class test decreases from $> 90\%$ to $< 9\%$), the likelihood of a student not being successful at the end of the first year increases by a factor 1.0358. The fact that the odds ratio is greater than 1 shows that the chemistry first test result is a strong predictor variable that affects academic success at the end of the first year of studies.

5.2.2.3 DIAGNOSTIC PROCEDURES

(1) The overall percentage of correct classification

The overall percentage of correct classification is 80.82%, a figure that indicates that the estimated logistic regression model is fairly reliable.

(2) Observed significance levels or P-values for each variable

The ability of an independent variable to explain the variability in the dependent variable is significant if the associated P-value is less than the level of significance α . Table 13 shows that the P-values for all the variables are small, and that all the variables that appear in the optimum logistic regression model thus have the capacity to account for the variability in the dependent variable Y.

(3) Estimated standard errors

All estimated standard errors in Table 13 are small. This indicates that the estimated logistic regression model performs well.

(4) The proportion of change in the -2Loglikelihood statistic

The value of the -2Loglikelihood statistic at the beginning of the backward elimination procedure was 487. The value of the same statistic at the end of the procedure was only

288. The proportion of decrease is equal to $(199/487) \times 100\% = 40.86\%$. This large decrease in the value of the statistic shows that the optimum model is good.

(5) Normal probability plots for studentized, leverage, and deviance residuals.

FIGURE 27

NORMAL P-PLOT OF STUDENTIZED RESIDUALS

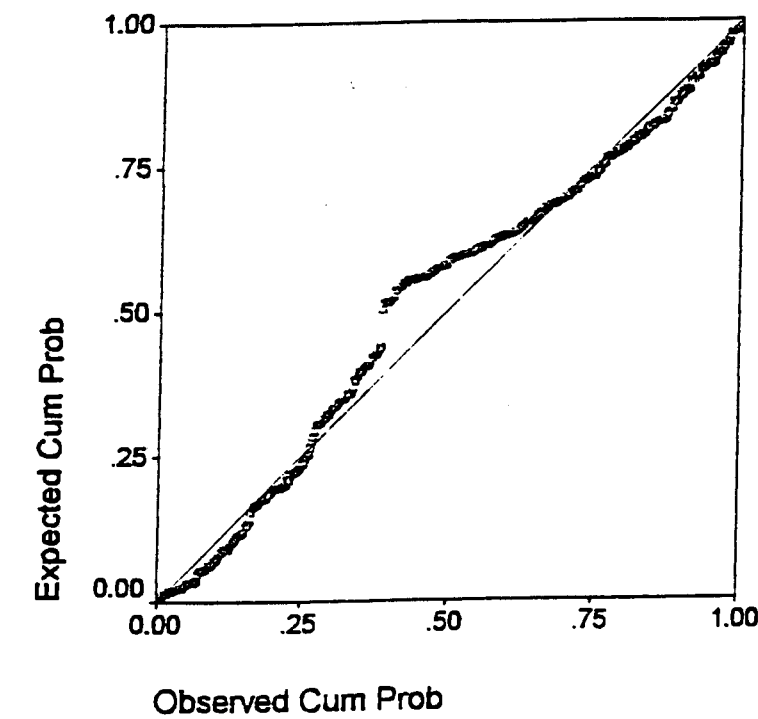
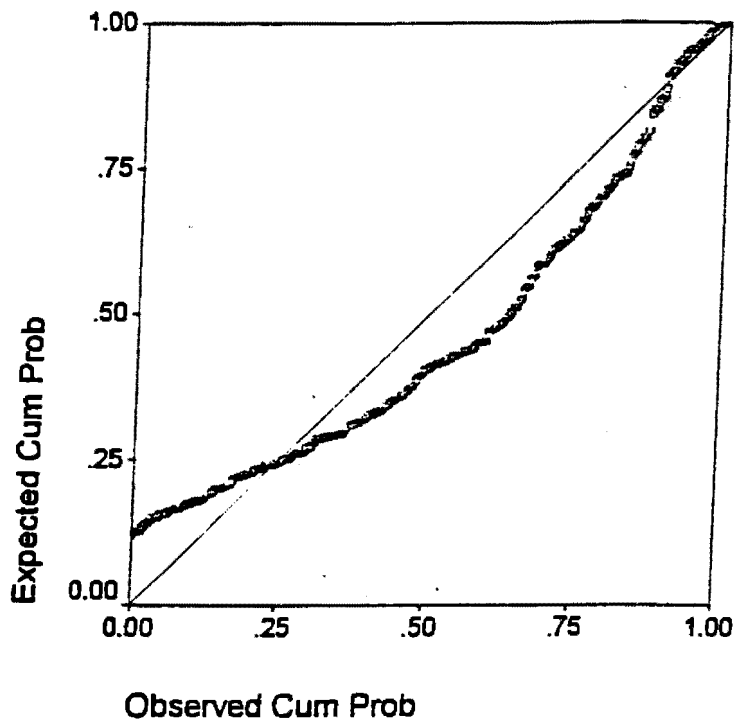
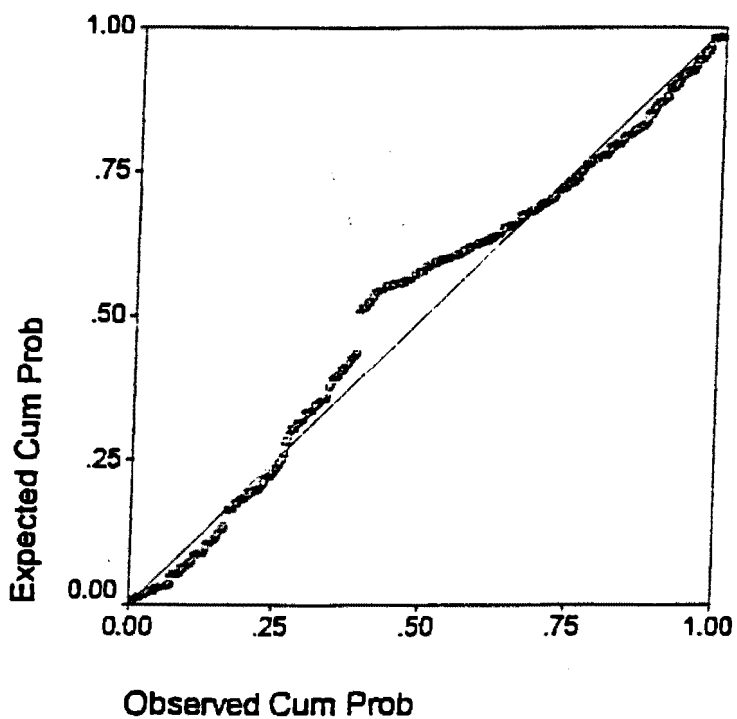


FIGURE 28**NORMAL P-PLOT OF LEVERAGE****FIGURE 29****NORMAL P-PLOT OF DEVIANCE**

The normal probability plots shown for the residuals are fairly S-shaped. This indicates that the error terms are approximately distributed normally.

5.2.2.4 CONCLUSION

The different diagnostic procedures shown above confirm that the estimated logistic regression model fits the data well.

An apparently accurate predictive model was estimated from the first test results in physiology, anatomy, biology and chemistry of all chiropractic and homoeopathy freshmen in the period 1989 to 1997 inclusive. As a predictive model developed from one set of data might not necessarily fit a different set of data, this model was validated on a different set of data.

5.2.3 CAN A LOGISTIC REGRESSION MODEL ESTIMATED RETROSPECTIVELY FROM TEST 1 RESULTS BE USED FOR THE EARLY IDENTIFICATION OF FUTURE AT RISK FRESHMEN?

In this section the logistic regression model estimated retrospectively from first test results was validated on the data from 1996 and 1997 in order to determine whether the model can be used for the early identification of future at risk freshmen.

In the figure below the ability of the logistic regression model to correctly identify $Y = 1$ (students not successful and therefore in need of support) is presented.

FIGURE 30

SENSITIVITY OF THE LOGISTIC REGRESSION MODEL ESTIMATED RETROSPECTIVELY FROM TEST 1 RESULTS

$$\begin{aligned}
 \text{Percentage of correct predictions} &= \frac{\text{Number correctly identified as not} \\
 \text{(Sensitivity)} & \quad \text{being successful}}{\text{Total number actually not being} \\
 & \quad \text{successful}} \times 100\% \\
 &= 39 / 42 \times 100\% \\
 &= 92.86\%
 \end{aligned}$$

Only 3 cases of students actually being at risk academically were not detected by this model where the estimated probabilities of the event occurring were 0.58, 0.61, and 0.85 respectively.

According to Hosmer & Lemeshow (1989) it is generally assumed that if the estimated probability of the event occurring is less than 0.5, then it is predicted that the event will not occur. An estimated probability of more than 0.5 will, on the other hand, lead to a prediction that the event will occur. In the case of the research reported here, and for the sake of increasing the screening ability of the predictive model, an arbitrary increase of the cut-off estimated probability of the event occurring from 0.5 to 0.65, thus correctly classifies a further 2 of these at risk students. The sensitivity of the predictive model thus increases:

$$\begin{aligned}\text{Sensitivity} &= 41 / 42 \times 100\% \\ &= 97.62\%\end{aligned}$$

$$\begin{aligned}\text{False negative (Type I error)} &= 21 / 61 \times 100\% \\ &= 34.43\%\end{aligned}$$

False positive (Type II error)

$$\begin{aligned}\text{With estimated probability} = 0.5 &= 3 / 42 \times 100\% \\ &= 7.14\%\end{aligned}$$

$$\begin{aligned}\text{With estimated probability} = 0.65 &= 1 / 42 \times 100\% \\ &= 2.38\%\end{aligned}$$

In the figure below the ability of the logistic regression model to correctly identify the proportion of successful students is presented.

FIGURE 31

SPECIFICITY OF THE LOGISTIC REGRESSION MODEL ESTIMATED RETROSPECTIVELY FROM TEST 1 RESULTS

$$\begin{aligned}
 \text{Specificity} &= \frac{\text{Number correctly identified as being successful}}{\text{Total number actually being successful}} \times 100\% \\
 &= 32 / 54 \times 100\% \\
 &= 59.26\%
 \end{aligned}$$

As discussed in Chapter 6 (Section 6.2.3) the 1996 chiropractic results dramatically influenced the specificity of the model. If these results are disregarded, the specificity of the estimated model increases as follows:

$$\begin{aligned}
 \text{Specificity} &= 29 / 37 \\
 &= 78.38\%
 \end{aligned}$$

5.2.3.1 CONCLUSION

The logistic regression model developed retrospectively and validated on a new set of data (1996 and 1997) delivered strong support for the use of first test results for the early identification of the at risk chiropractic and homoeopathy freshmen. In the next section the possibility of utilizing second test results for the early identification of at risk freshmen is investigated.

5.3 STUDY 3: TEST 2 RESULTS

In the previous section first test results emerged as good predictors of the freshman in academic difficulty and thus of the freshman in need of support. It would, however, also be very useful to be able to use second test results for an identification of the at risk freshman, but no previous research had yet implicated second test results as predictors of success. In this study an attempt was thus made to investigate whether a relationship could be demonstrated between second test results and categorization as successful, dropback, academic exclusion, or voluntary withdrawal at the end of the first year of studies in chiropractic and homoeopathy.

5.3.1 IS THERE A RELATIONSHIP BETWEEN RESULTS OBTAINED IN THE SECOND TESTS AND SUCCESS OR FAILURE AT THE END OF THE FIRST YEAR OF STUDIES?

For each scoring bracket (e.g. 50-59%) obtained in the second physiology test, the academic outcome of all freshmen who had obtained such a score over the period 1989 to 1997 was calculated. When displayed in Table form, the data could indicate exactly what percentage of all students who had performed at a certain level in this test had been successful (coded as 1), or had had serious academic difficulties in that they became a dropback (coded as 2) or an academic exclusion (coded as 3) at the end of the freshman year. At the same time it could also indicate for every level of performance in the second physiology test what percentage of the students would remain in the system at the end of the year (successful students plus dropbacks) or what percentage would be at risk (dropbacks plus voluntary withdrawals).

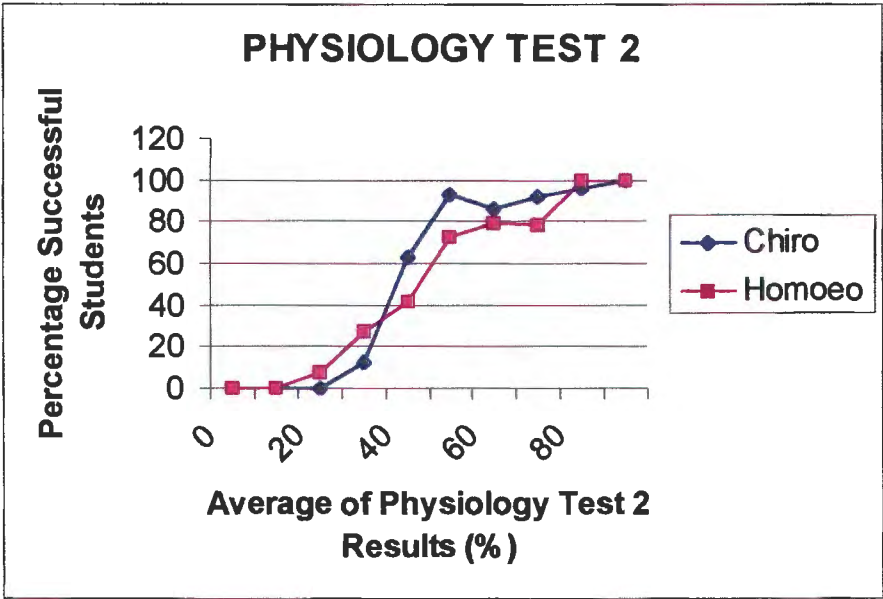
TABLE 14**PHYSIOLOGY TEST 2 – STUDENTS PER CATEGORY**

	CHIROPRACTIC	HOMOEOPATHY
Students with < 9%	1 - 2 - 3 - Total 0	1 -) 2 -) 0% 3 1 100%) 100% Total 1
Students with 10-19%	1 -) 2 -) 0% 3 3 100%) 100% Total 3 (1%)	1 -) 2 1 25%)) 25% 3 3 75%) 100% Total 4 (2%)
Students with 20-29%	1 -) 2 2 14%)) 14% 3 12 86%) 100% Total 14 (6%)	1 2 8%)) 2 7 27%)) 35% 3 17 65%) 92% Total 26 (11%)
Students with 30-39%	1 3 13%)) 2 7 30%)) 43% 3 13 57%) 87% Total 23 (9%)	1 7 27%)) 2 10 38%)) 65% 3 9 35%) 73% Total 26 (11%)
Students with 40-49%	1 20 63%)) 2 10 31%)) 94% 3 2 6%)) 37% Total 32 (13%)	1 18 42%)) 2 14 32%)) 74% 3 11 26%) 58% Total 43 (17%)
Students with 50-59%	1 37 93%)) 2 1 2%)) 95% 3 2 5%)) 7% Total 40 (16%)	1 25 73%)) 2 5 15%)) 88% 3 4 12%) 27% Total 34 (14%)
Students with 60-69%	1 44 86%)) 2 4 8%)) 94% 3 3 6%)) 14% Total 51 (20%)	1 37 79%)) 2 6 13%)) 92% 3 4 8%)) 21% Total 47 (19%)
Students with 70-79%	1 57 92%)) 2 3 5%)) 97% 3 2 3%)) 8% Total 62 (25%)	1 28 78%)) 2 6 17%)) 95% 3 2 5%)) 22% Total 36 (15%)
Students with 80-89%	1 24 96%)) 2 -)) 96% 3 1 4%)) 4% Total 25 (10%)	1 27 100%)) 2 -)) 100% 3 -) 0% Total 27 (11%)
Students with > 90%	1 1 100%)) 2 -)) 100% 3 -) 0% Total 1	1 2 100%)) 2 -)) 100% 3 -) 0% Total 2 (1%)

Table 14 indicates a clear relationship between the scores obtained in the second physiology test and success and retention at the end of the first year of studies. The higher the results obtained in the second physiology test, the higher the percentage of freshmen in both programmes who were successful at the end of the year.

In order to demonstrate the trends that became apparent from the data in Table 14, four graphs were constructed, each illustrating a specific aspect of attrition that is important from an institutional point of view. The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the second physiology test and the percentage of successful freshmen per performance category.

FIGURE 32
PERCENTAGE SUCCESSFUL FRESHMEN PER AVERAGE PHYSIOLOGY TEST 2 RESULTS

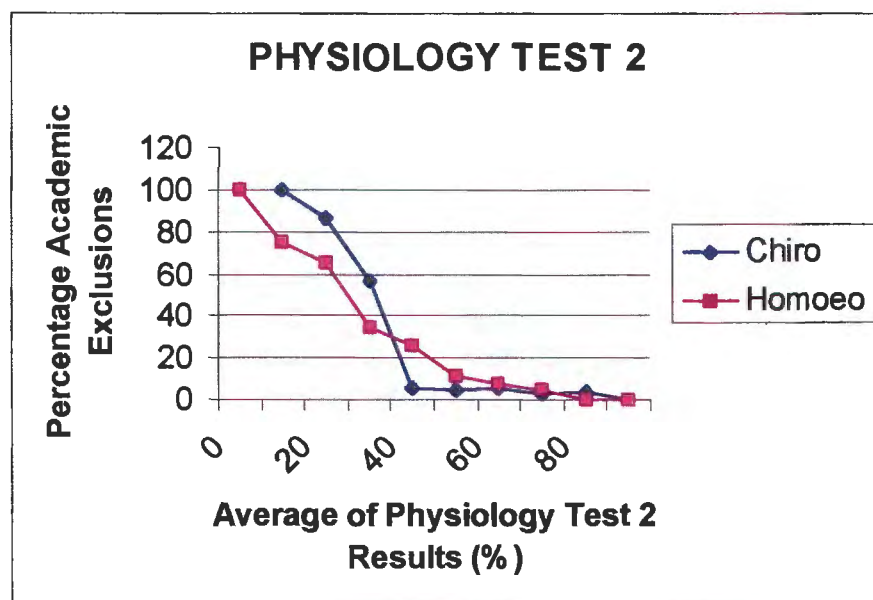


From Figure 32 there seems to be a relationship between performance in the second physiology test and success (students coded as 1) at the end of the first year of studies. For both programmes, students who had scored above 80% in this test had a high success rate. Chiropractic students who had scored above 50% in this test had a success rate of >90%, whilst homoeopathy students only achieved a similar success rate at scores above 80%. The graph indicates that the chiropractic students generally had a slightly better success rate at the end of the year than the homoeopathy students with similar scores in the second physiology test.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the second physiology test and the percentage of academic exclusions per performance category.

FIGURE 33

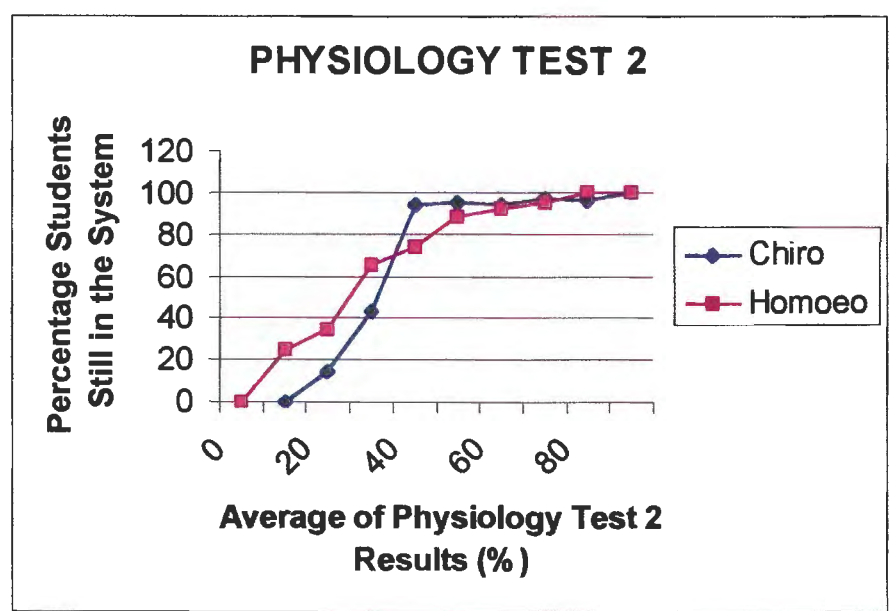
PERCENTAGE FRESHMEN WHO BECAME ACADEMIC EXCLUSIONS PER AVERAGE PHYSIOLOGY TEST 2 RESULTS



From Figure 33 there seems to be a relationship between performance in the second physiology test and students who had to discontinue their studies because of academic exclusion at the end of the first year (students coded as 3). Of the students with scores above 40% in this test the chiropractic students had a very low academic exclusion rate.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the second physiology test and the percentage of students who remained in the system (successful students plus dropbacks).

FIGURE 34
PERCENTAGE FRESHMEN WHO REMAINED IN THE SYSTEM PER
AVERAGE PHYSIOLOGY TEST 2 RESULTS



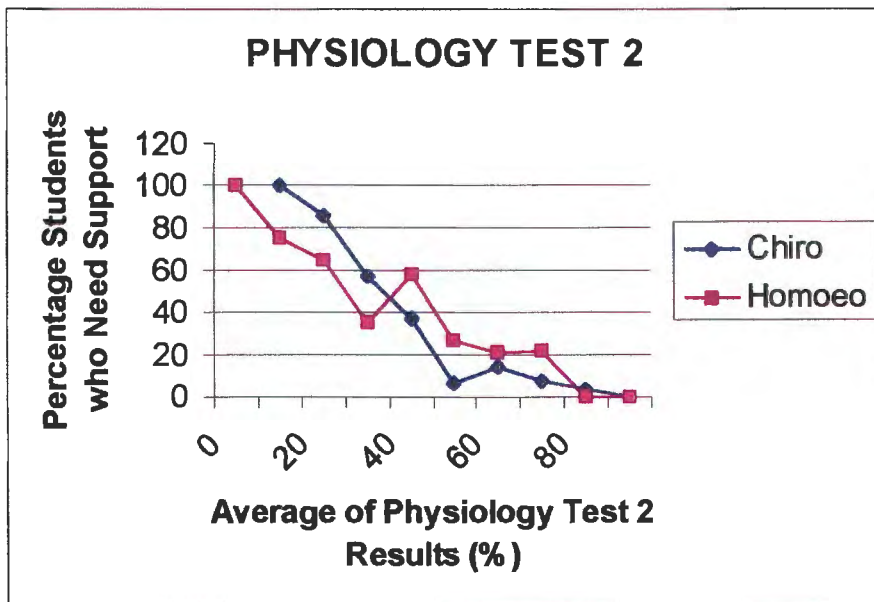
From Figure 34 there seems to be a relationship between performance in the second physiology test and student retention at the end of the first year (students coded as 1 and 2). The graph indicates that the retention rate for chiropractic students with scores of

above 40% in this test was >90%, whilst a comparable result was only achieved by homoeopathy students who had scored higher than 60% in this test. For both groups, however, students who had obtained more than 60% in the second physiology test had on average a >90% retention rate.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the second physiology test and the percentage of students who would require support in order to become successful at the end of the year (dropbacks plus academic exclusions).

FIGURE 35

**PERCENTAGE FRESHMEN WHO WOULD REQUIRE SUPPORT PER
AVERAGE PHYSIOLOGY TEST 2 RESULTS**



From Figure 35 there seems to be a relationship between performance in the second physiology test and students who would need support during the first year of studies, i.e. those students coded as 2 (dropbacks) and 3 (academic exclusions). The graph indicates

that of the students in the lower scoring brackets (< 60%) fewer chiropractic than homoeopathy students would appear to need support, i.e. fewer students became dropbacks or academic exclusions. In the higher scoring brackets (>60%), however, the opposite situation would appear to exist.

A possible relationship between performance in the second anatomy test and academic outcome at the end of the freshman year was also investigated. For each scoring bracket (e.g. 50-59%) obtained in the second anatomy test, the academic outcome of all freshmen who had obtained such a score over the period 1989 to 1997 was calculated. When displayed in Table form, the data could indicate exactly what percentage of all students who had performed at a certain level in this test had been successful (coded as 1), or had had serious academic difficulties in that they became a dropback (coded as 2) or an academic exclusion (coded as 3) at the end of the freshmen year. At the same time it could also indicate for every level of performance in the second anatomy test what percentage of the students would remain in the system at the end of the year (successful students plus dropbacks) or what percentage would be at risk (dropbacks plus voluntary withdrawals).

TABLE 15**ANATOMY TEST 2 – STUDENTS PER CATEGORY**

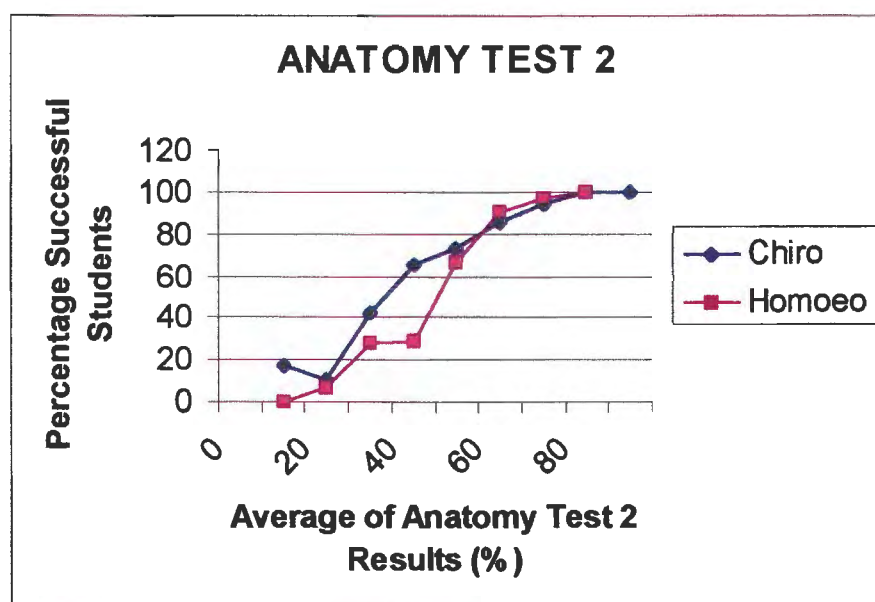
	CHIROPRACTIC	HOMOEOPATHY
Students with < 9%	1 -) 2 -) 0% 3 1 100%) 100% Total 1	1 -) 2 2 100%) 100% 3 -) 100% Total 2 (1%)
Students with 10-19%	1 1 17%) 2 1 17%) 34% 3 4 66%) 83% Total 6 (2%)	1 -) 2 1 17%) 17% 3 5 83%) 100% Total 6 (2%)
Students with 20-29%	1 2 11%) 2 4 21%) 32% 3 13 68%) 89% Total 19 (75)	1 1 7%) 2 7 50%) 57% 3 6 43%) 93% Total 14 (6%)
Students with 30-39%	1 10 42%) 2 3 12%) 54% 3 11 46%) 58% Total 24 (9%)	1 9 28%) 2 9 28%) 56% 3 14 44%) 72% Total 32 (13%)
Students with 40-49%	1 39 65%) 2 8 13%) 78% 3 13 22%) 35% Total 60 (22%)	1 12 29%) 2 13 32%) 61% 3 16 39%) 71% Total 41 (16%)
Students with 50-59%	1 33 73%) 2 7 16%) 89% 3 5 11%) 27% Total 45 (16%)	1 39 66%) 2 13 22%) 88% 3 7 12%) 34% Total 59 (23%)
Students with 60-69%	1 52 85%) 2 9 15%) 100% 3 -) 15% Total 61 (22%)	1 44 90%) 2 3 6%) 96% 3 2 4%) 10% Total 49 (19%)
Students with 70-79%	1 44 94%) 2 1 2%) 96% 3 2 4%) 6% Total 47 (17%)	1 31 97%) 2 1 3%) 100% 3 -) 3% Total 32 (13%)
Students with 80-89%	1 14 100%) 2 -) 100% 3 -) 0% Total 14 (5%)	1 17 100%) 2 -) 100% 3 -) 0% Total 17 (7%)
Students with > 90%	1 1 100%) 2 -) 100% 3 -) 0% Total 1	1 - 2 - 3 - Total 0

Table 15 indicates a clear relationship between the scores obtained in the second anatomy test and success and retention at the end of the first year of studies. The higher the results obtained in the second anatomy test, the higher the percentage of freshmen in both programmes who were successful at the end of the year.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the second anatomy test and the percentage of successful freshmen per performance category.

FIGURE 36

**PERCENTAGE SUCCESSFUL FRESHMEN PER AVERAGE ANATOMY TEST
2 RESULTS**



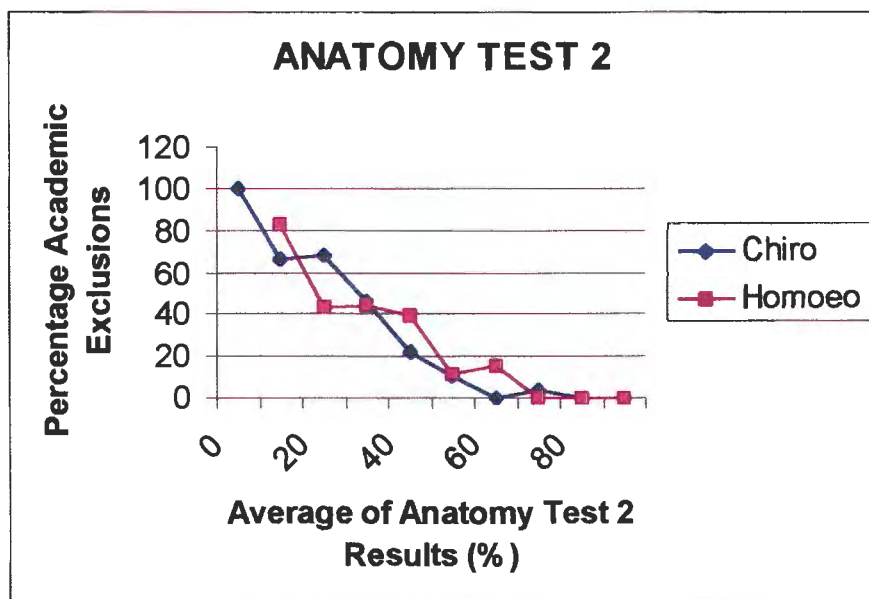
From Figure 36 there seems to be a relationship between performance in the second anatomy test and success (students coded as 1) at the end of the first year of studies. For both programmes, students who had scored above 70% in this test had a >90% success

rate. Of all the students in the lower scoring brackets (below 60%), it appears as though the chiropractic students had a higher success rate than the homoeopathy students with similar scores in the second anatomy test.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the second anatomy test and the percentage of academic exclusions per performance category.

FIGURE 37

PERCENTAGE FRESHMEN WHO BECAME ACADEMIC EXCLUSIONS PER AVERAGE ANATOMY TEST 2 RESULTS



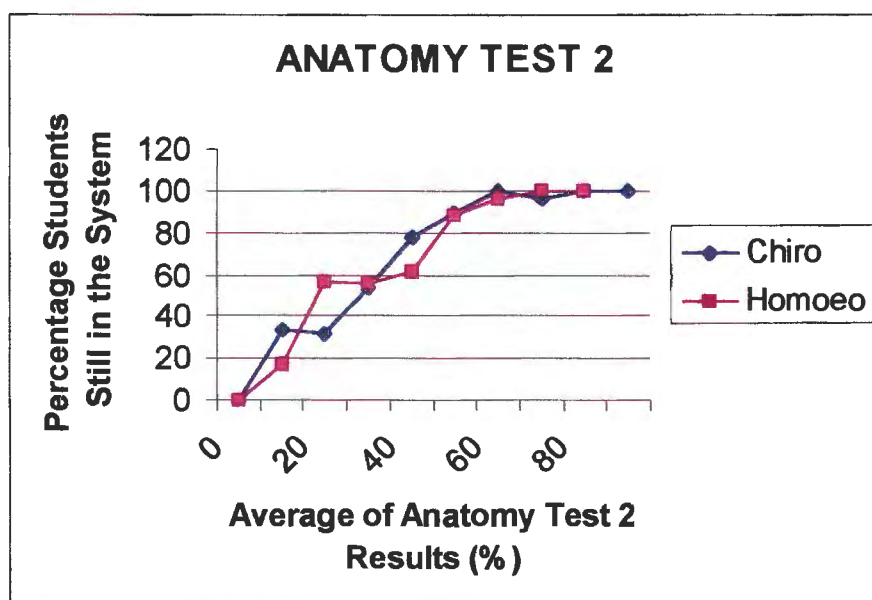
From Figure 37 there seems to be a relationship between performance in the second anatomy test and students who had to discontinue their studies because of academic exclusion at the end of the first year (students coded as 3). The two programmes show a

very similar pattern of academic exclusion relative to scores obtained in the second anatomy test, with students who had scored above 60% having a very low exclusion rate.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the second anatomy test and the percentage of students who remained in the system (successful students plus dropbacks).

FIGURE 38

PERCENTAGE FRESHMEN WHO REMAINED IN THE SYSTEM PER AVERAGE ANATOMY TEST 2 RESULTS

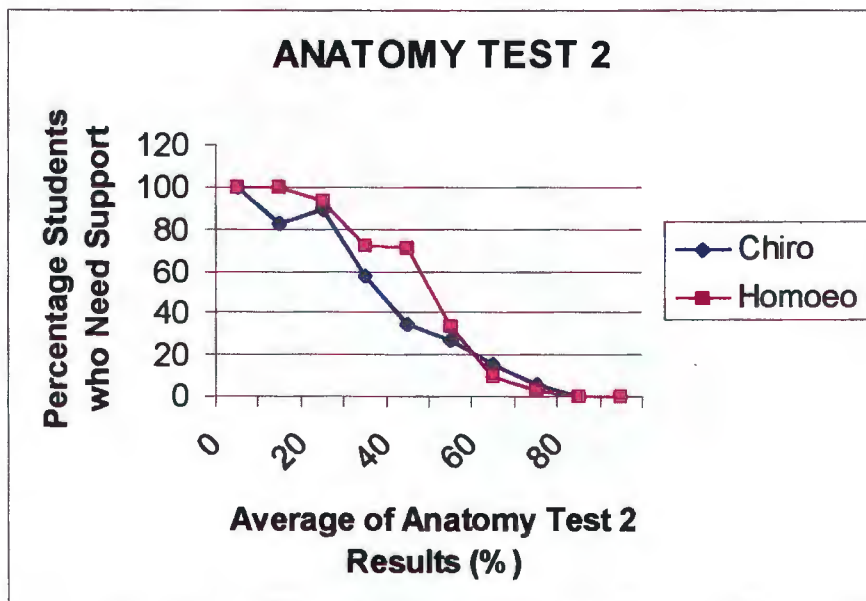


From Figure 38 there seems to be a relationship between performance in the second anatomy test and student retention at the end of the first year (students coded as 1 and 2). The two programmes show a similar pattern, with students who had scored above 60% in this test on average having a very good retention rate.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the second anatomy test and the percentage of students who would require support in order to become successful at the end of the year (dropbacks plus academic exclusions).

FIGURE 39

PERCENTAGE FRESHMEN WHO WOULD NEED SUPPORT PER AVERAGE ANATOMY TEST 2 RESULTS



From Figure 39 there seems to be a relationship between performance in the second anatomy test and students who would need support during the first year of studies, i.e. those coded as 2 (dropbacks) and 3 (academic exclusions). Of the students who had scored above 70% in this test, only 6% of chiropractic and 3% homoeopathy students would require support. The graph indicates that for all students in the lower scoring brackets (below 60%), fewer chiropractic than homoeopathy students needed support in order to become successful, i.e. fewer students became dropbacks or academic exclusions.

A possible relationship between performance in the second biology test and academic outcome at the end of the freshman year was also investigated. For each scoring bracket (e.g. 50-59%) obtained in the second biology test, the academic outcome of all freshmen who had obtained such a score over the period 1989 to 1997 was calculated. When displayed in Table form, the data could indicate exactly what percentage of all students who had performed at a certain level in this test had been successful (coded as 1), or had had serious academic difficulties in that they became a dropback (coded as 2) or an academic exclusion (coded as 3) at the end of the freshmen year. At the same time it could also indicate for every level of performance in the second biology test what percentage of the students would remain in the system at the end of the year (successful students plus dropbacks) or what percentage would be at risk (dropbacks plus voluntary withdrawals).

TABLE 16**BIOLOGY TEST 2 – STUDENTS PER CATEGORY**

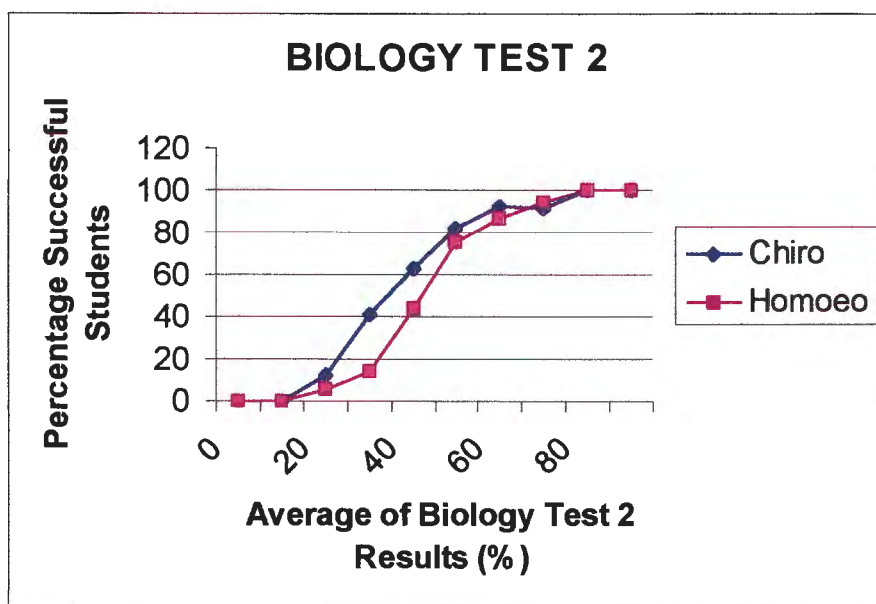
	CHIROPRACTIC	HOMOEOPATHY
Students with < 9%	1 - 2 - 3 - Total 0	1 -) 2 -) 0% 3 1 100%) 100% Total 1
Students with 10-19%	1 -) 2 2 33%)) 33% 3 4 67%) 100% Total 6 (2%)	1 -) 2 1 20%)) 20% 3 4 80%) 100% Total 5 (2%)
Students with 20-29%	1 2 12%) 2 3 19%)) 31% 3 11 69%) 88% Total 16 (6%)	1 1 6%) 2 3 19%)) 25% 3 12 75%) 94% Total 16 (7%)
Students with 30-39%	1 13 41%) 2 8 25%)) 66% 3 11 34%) 59% Total 32 (13%)	1 4 14%) 2 7 25%)) 39% 3 17 61%) 86% Total 28 (12%)
Students with 40-49%	1 29 63%) 2 9 20%)) 83% 3 8 17%) 37% Total 46 (18%)	1 18 44%) 2 15 36%)) 80% 3 8 20%) 56% Total 41 (18%)
Students with 50-59%	1 54 82%) 2 8 12%)) 94% 3 4 6%) 12% Total 66 (26%)	1 33 75%) 2 8 18%)) 93% 3 3 7%) 25% Total 44 (20%)
Students with 60-69%	1 41 92%) 2 1 2%)) 94% 3 3 7%) 9% Total 45 (18%)	1 35 87%) 2 4 10%)) 97% 3 1 3%) 13% Total 40 (18%)
Students with 70-79%	1 30 91%) 2 1 3%)) 94% 3 2 6%) 9% Total 33 (13%)	1 31 94%) 2 2 6%)) 100% 3 -) 6% Total 33 (15%)
Students with 80-89%	1 6 100%) 2 -)) 100% 3 -) 0% Total 6 (2%)	1 17 100%) 2 -)) 100% 3 -) 0% Total 17 (8%)
Students with > 90%	1 1 100%) 2 -)) 100% 3 -) 0% Total 1	1 1 100%) 2 -)) 100% 3 -) 0% Total 1

Table 14 indicates a clear relationship between the scores obtained in the second biology test and success and retention at the end of the first year of studies. The higher the results obtained in the second biology test, the higher the percentage of freshmen in both programmes who were successful at the end of the year.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the second biology test and the percentage of successful freshmen per performance category.

FIGURE 40

PERCENTAGE SUCCESSFUL FRESHMEN PER AVERAGE BIOLOGY TEST 2 RESULTS

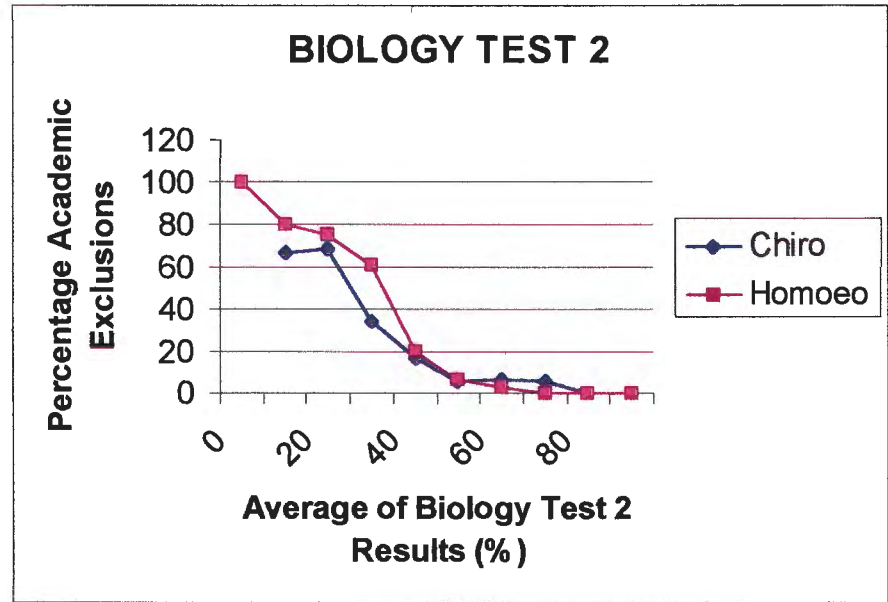


From Figure 40 there seems to be a relationship between performance in the second biology test and success (coded as 1) at the end of the first year of studies. For both programmes those students who had scored above 70% in this test had an above 90%

success rate. Of all students who had scored below 70% in this test, it appears as though the chiropractic students had a better success rate than the homoeopathy students.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the second biology test and the percentage of academic exclusions per performance category

FIGURE 41
PERCENTAGE FRESHMEN WHO BECAME ACADEMIC EXCLUSIONS PER AVERAGE ANATOMY TEST 2 RESULTS

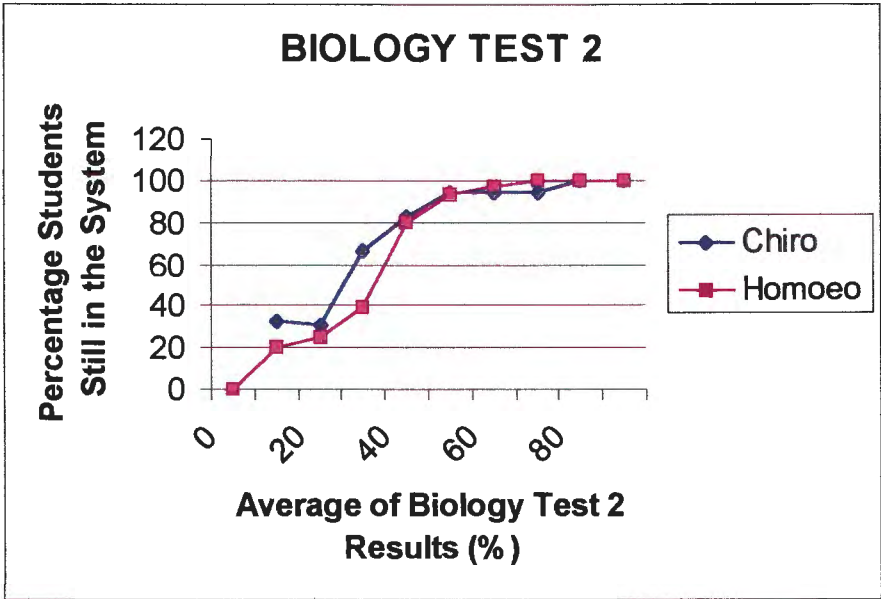


From Figure 41 there seems to be a relationship between performance in the second biology test and students who had to discontinue their studies because of academic exclusion at the end of the first year (students coded as 3). All students who had scored above 80% in this test had a 0% exclusion rate. Exclusion rates were generally low (<7%) for both groups for all those students who had scored above 50% in the second biology test. Of all students in the lower scoring brackets (<50%), it appeared as though

the chiropractic students had a lower academic exclusion rate than the homoeopathy students.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the second biology test and the percentage of students who remained in the system (successful students plus dropbacks).

FIGURE 42
PERCENTAGE FRESHMEN WHO REMAINED IN THE SYSTEM PER
AVERAGE BIOLOGY TEST 2 RESULTS

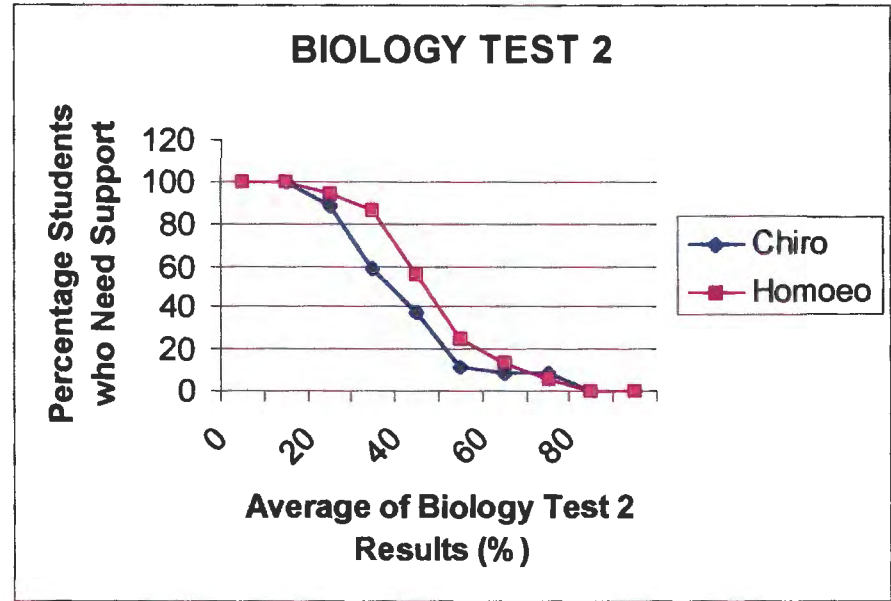


From Figure 42 there seems to be a relationship between performance in the second biology test and student retention at the end of the first year (students coded as 1 and 2). For both programmes the retention rate of those students who had scored above 50% in this test was >90%. Of those students in the lower scoring brackets (<50%), the graph

indicates that the chiropractic students had a slightly better retention rate than the homoeopathy students.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the second biology test and the percentage of students who would require support in order to become successful at the end of the year (dropbacks plus academic exclusions).

FIGURE 43
PERCENTAGE FRESHMEN WHO WOULD REQUIRE SUPPORT PER
AVERAGE BIOLOGY TEST 2 RESULTS



From Figure 43 there seems to be a relationship between performance in the second biology test and students who would need support during their first year of studies, i.e. those students coded as 2 (dropbacks) and 3 (academic exclusions). Of the students who had scored above 80% in this test, none would need support. However, some form of

support is indicated for all students with scores below 80%. The graph indicates that for all levels of performance in the second biology test, fewer chiropractic than homoeopathy students needed support in order to become successful, i.e. fewer students became drop-backs or academic exclusions.

A possible relationship between performance in the second chemistry test and academic outcome at the end of the freshman year was also investigated. For each scoring bracket (e.g. 50-59%) obtained in the second chemistry test, the academic outcome of all freshmen who had obtained such a score over the period 1989 to 1997 was calculated. When displayed in Table form, the data could indicate exactly what percentage of all students who had performed at a certain level in this test had been successful (coded as 1), or had had serious academic difficulties in that they became a dropback (coded as 2) or an academic exclusion (coded as 3) at the end of the freshmen year. At the same time it could also indicate for every level of performance in the second chemistry test what percentage of the students would remain in the system at the end of the year (successful students plus dropbacks) or what percentage would be at risk (dropbacks plus voluntary withdrawals).

TABLE 17

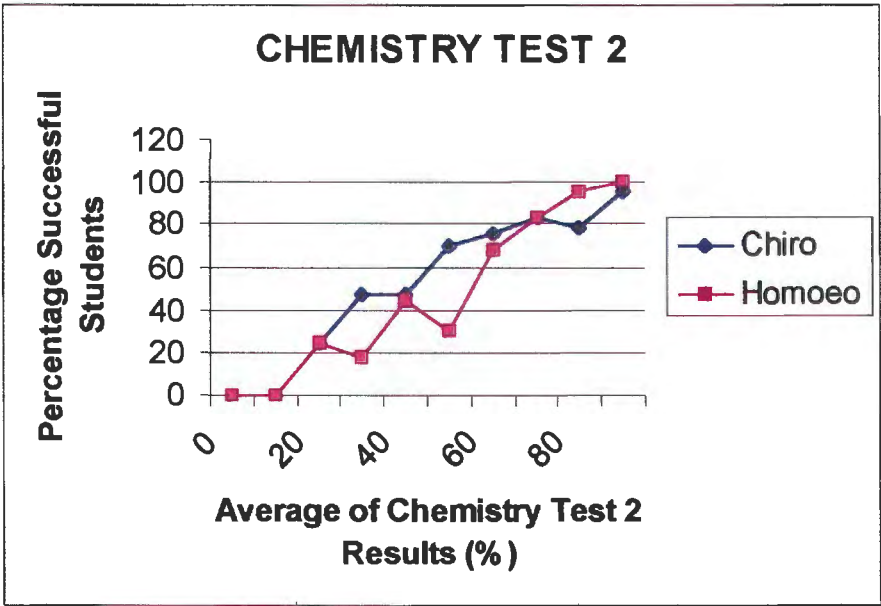
CHEMISTRY TEST 2 – STUDENTS PER CATEGORY

	CHIROPRACTIC	HOMOEOPATHY
Students with < 9%	1 - 2 - 3 - Total 0	1 -) 2 1 50%) 50% 3 1 50%) 100% Total 2
Students with 10-19%	1 -) 2 -) 0% 3 3 100%) 100% Total 3 (1%)	1 -) 2 -) 0% 3 2 100%) 100% Total 2 (1%)
Students with 20-29%	1 1 25%) 2 -) 25% 3 3 75%) 75% Total 4(2%)	1 2 25%) 2 3 37%) 62% 3 3 38%) 75% Total 8 (4%)
Students with 30-39%	1 9 47%) 2 3 16%) 63% 3 7 37%) 53% Total 19 (8%)	1 3 18%) 2 5 29%) 47% 3 9 53%) 82% Total 17 (8%)
Students with 40-49%	1 14 47%) 2 6 20%) 67% 3 10 33%) 53% Total 30 (12%)	1 15 44%) 2 8 24%) 68% 3 11 32%) 56% Total 34 (15%)
Students with 50-59%	1 35 70%) 2 6 12%) 82% 3 9 18%) 30% Total 50 (20%)	1 12 30%) 2 14 35%) 65% 3 14 35%) 70% Total 40 (18%)
Students with 60-69%	1 39 76%) 2 8 16%) 92% 3 4 8%) 24% Total 51 (21%)	1 34 68%) 2 9 18%) 86% 3 7 14%) 32% Total 50 (22%)
Students with 70-79%	1 44 83%) 2 4 8%) 91% 3 5 9%) 17% Total 53 (21%)	1 34 83%) 2 7 17%) 100% 3 -) 17% Total 41 (18%)
Students with 80-89%	1 14 78%) 2 2 11%) 89% 3 2 11%) 22% Total 18 (7%)	1 21 95%) 2 1 5%) 100% 3 -) 5% Total 22 (10%)
Students with > 90%	1 19 95%) 2 -) 95% 3 1 5%) 5% Total 20 (8%)	1 9 100%) 2 -) 100% 3 -) 0% Total 9 (4%)

Table 17 indicates a relationship between the scores obtained in the second chemistry test and success and retention at the end of the first year of studies. The higher the results obtained in the second chemistry test, the higher the percentage of freshmen in both programmes who were successful at the end of the year.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the second chemistry test and the percentage of successful freshmen per performance category.

FIGURE 44
PERCENTAGE SUCCESSFUL FRESHMEN PER AVERAGE CHEMISTRY
TEST 2 RESULTS



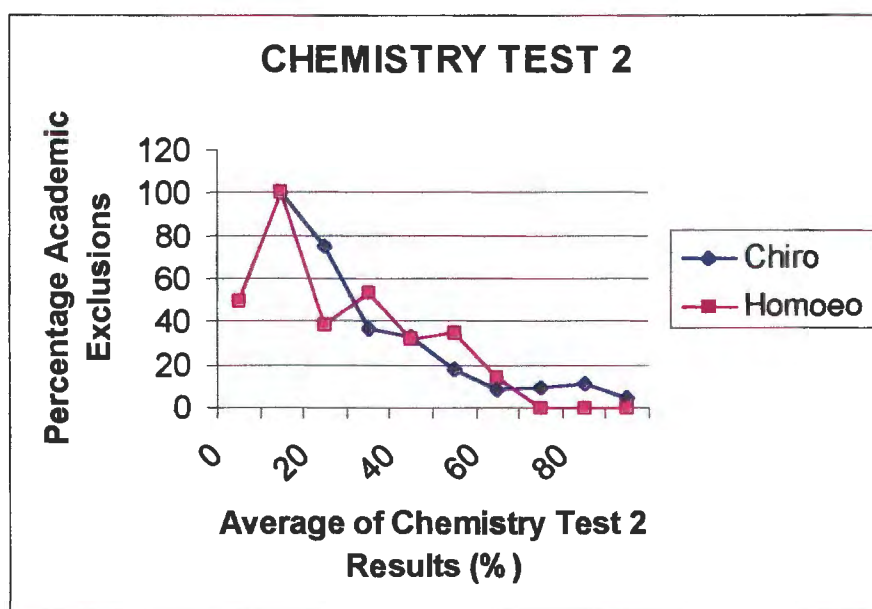
From Figure 44 there seems to be a relationship between performance in the second chemistry test and success (coded as 1) at the end of the first year of studies. Only those homoeopathy students who had scored above 80% and chiropractic students who had

scored above 90% in this test had a >90% success rate. Of all the students with second chemistry test scores below 70%, it appears as though the chiropractic students had a higher success rate than the homoeopathy students.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the second chemistry test and the percentage of academic exclusions per performance category.

FIGURE 45

PERCENTAGE FRESHMEN WHO BECAME ACADEMIC EXCLUSIONS PER AVERAGE CHEMISTRY TEST 2 RESULTS



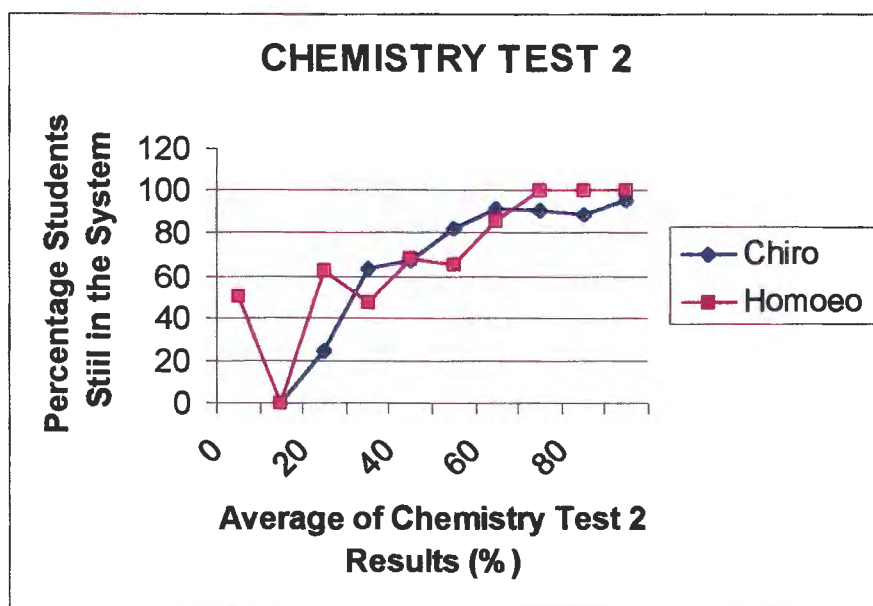
From Figure 45 there seems to be a relationship between performance in the second chemistry test and students who had to discontinue their studies because of academic exclusion at the end of the first year (students coded as 3). All homoeopathy students who had scored above 70% in the second chemistry test had a 0% academic exclusion

rate. However, the graph indicates that chiropractic students with comparable scores still became academic exclusions.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the second chemistry test and the percentage of students who remained in the system (successful students plus dropbacks).

FIGURE 46

**PERCENTAGE FRESHMEN WHO REMAINED IN THE SYSTEM PER
AVERAGE CHEMISTRY TEST 2 RESULTS**

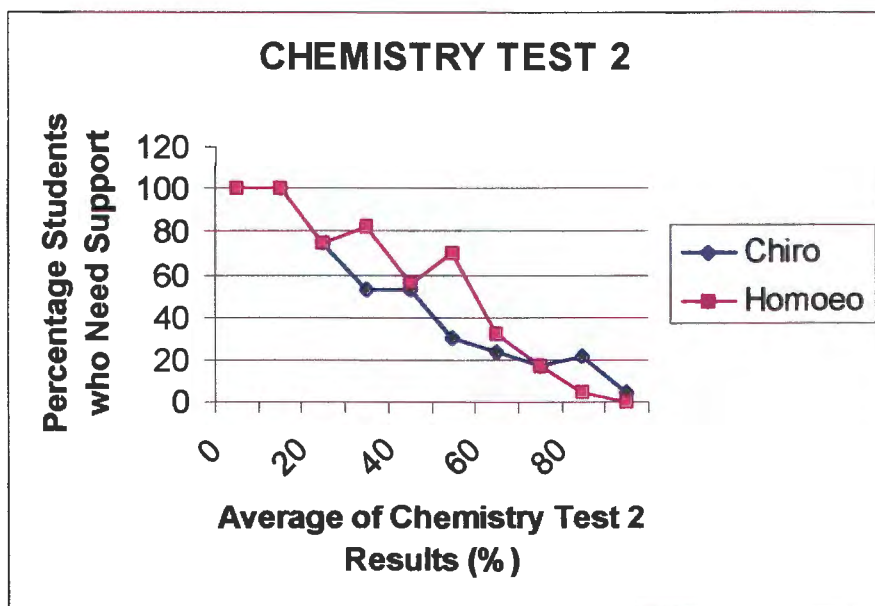


From Figure 46 there seems to be a relationship between performance in the second chemistry test and student retention at the end of the first year (students coded as 1 and 2). All homoeopathy students who had scored above 70% in this test had a 100% retention rate.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the second chemistry test and the percentage of students who would require support in order to become successful at the end of the year (dropbacks plus academic exclusions).

FIGURE 47

**PERCENTAGE FRESHMEN WHO WOULD REQUIRE SUPPORT PER
AVERAGE CHEMISTRY TEST 2 RESULTS**



From Figure 47 there seems to be a relationship between performance in the second chemistry test and students who would need support during their first year of studies, i.e. those students coded as 2 (dropbacks) and 3 (academic exclusions). Except for those homoeopathy students who had scored above 90%, it appears as though some form of support would be required for all students in the two programmes. The graph indicates that of all chemistry second test scores below 70%, fewer chiropractic than homoeopathy students needed support, i.e. fewer students became dropbacks or academic exclusions.

A possible relationship between performance in the second physics test and academic outcome at the end of the freshman year was also investigated. For each scoring bracket (e.g. 50-59%) obtained in the second physics test, the academic outcome of all freshmen who had obtained such a score over the period 1989 to 1997 was calculated. When displayed in Table form, the data could indicate exactly what percentage of all students who had performed at a certain level in this test had been successful (coded as 1), or had had serious academic difficulties in that they became a drop-back (coded as 2) or an academic exclusion (coded as 3) at the end of the freshmen year. At the same time it could also indicate for every level of performance in the second physics test what percentage of the students would remain in the system at the end of the year (successful students plus dropbacks) or what percentage would be at risk (dropbacks plus voluntary withdrawals).

TABLE 18

PHYSICS TEST 2 – STUDENTS PER CATEGORY

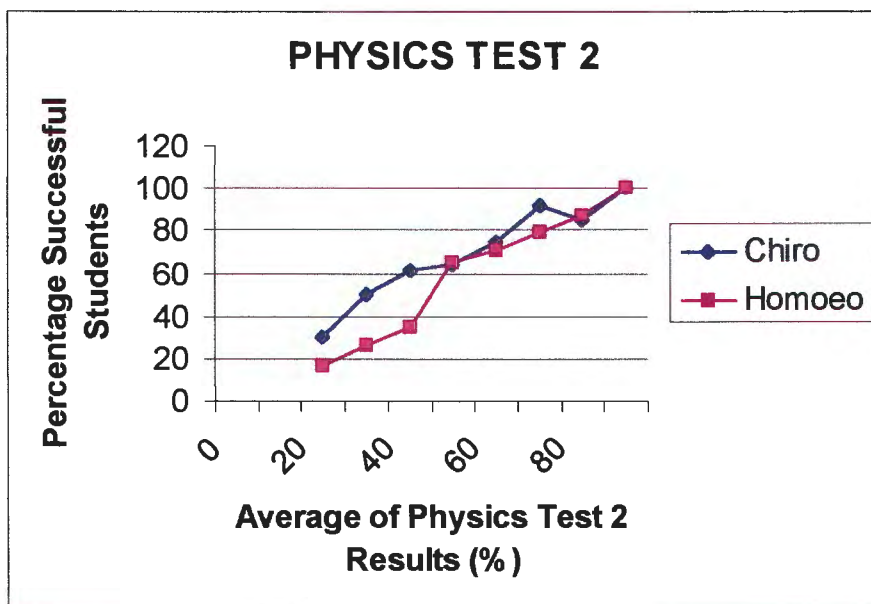
	CHIROPRACTIC	HOMOEOPATHY
Students with < 9%	1 - 2 - 3 - Total 0	1 - 2 - 3 - Total 0
Students with 10-19%	1 - 2 - 3 - Total 0	1 - 2 - 3 - Total 0
Students with 20-29%	1 3 30%) 2 1 10%)) 40% 3 6 60%) 70% Total 10 (4%)	1 1 17%) 2 -)) 17% 3 5 83%) 83% Total 6 (3%)
Students with 30-39%	1 8 50%) 2 4 25%)) 75% 3 4 25%) 50% Total 16 (7%)	1 5 26%) 2 6 32%)) 58% 3 8 42%) 74% Total 19 (9%)
Students with 40-49%	1 27 61%) 2 3 7%)) 68% 3 14 32%) 39% Total 44 (19%)	1 12 35%) 2 8 24%)) 59% 3 14 41%) 65% Total 34 (17%)
Students with 50-59%	1 32 64%) 2 7 14%)) 78% 3 11 22%) 36% Total 50 (21%)	1 35 65%) 2 12 22%)) 87% 3 7 13%) 35% Total 54 (27%)
Students with 60-69%	1 47 75%) 2 10 16%)) 91% 3 6 9%) 25% Total 63 (27%)	1 27 71%) 2 8 21%)) 92% 3 3 8%) 29% Total 38 (19%)
Students with 70-79%	1 36 92%) 2 -)) 92% 3 3 8%) 8% Total 39 (16%)	1 26 79%) 2 4 12%)) 91% 3 3 9%) 21% Total 33 (16%)
Students with 80-89%	1 11 85%) 2 2 15%)) 100% 3 -) 15% Total 13 (5%)	1 13 87%) 2 2 13%)) 100% 3 -) 13% Total 15 (7%)
Students with > 90%	1 2 100%) 2 -)) 100% 3 -) 0% Total 2 (1%)	1 3 100%) 2 -)) 100% 3 -) 0% Total 3 (2%)

Table 18 indicates a relationship between the scores obtained in the second physics test and success and failure at the end of the first year of studies. The higher the results obtained in the second physics test, the higher the percentage of freshmen in both programmes who were successful at the end of the year.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the second physics test and the percentage of successful freshmen per performance category.

FIGURE 48

PERCENTAGE SUCCESSFUL FRESHMEN PER AVERAGE PHYSICS TEST 2 RESULTS



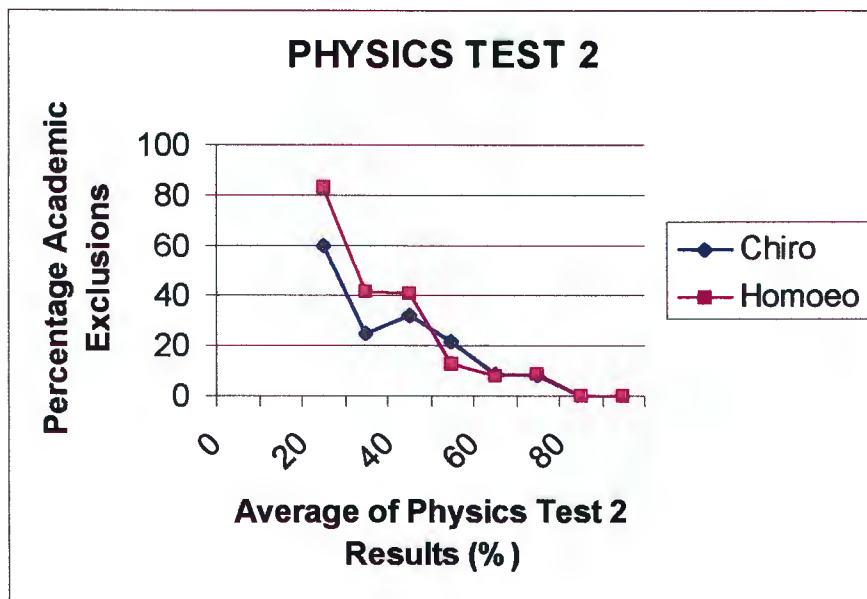
From Figure 48 there seems to be a relationship between performance in the second physics test and success (coded as 1) at the end of the first year of studies. For both programmes, however, only those students who had scored above 90% in this test had a

100% success rate. Of the lower scoring students (<80%) it appears as though the chiropractic students had a better success rate than the homoeopathy students with similar scores.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the second physics test and the percentage of academic exclusions per performance category.

FIGURE 49

PERCENTAGE FRESHMEN WHO BECAME ACADEMIC EXCLUSIONS PER AVERAGE PHYSICS TEST 2 RESULTS

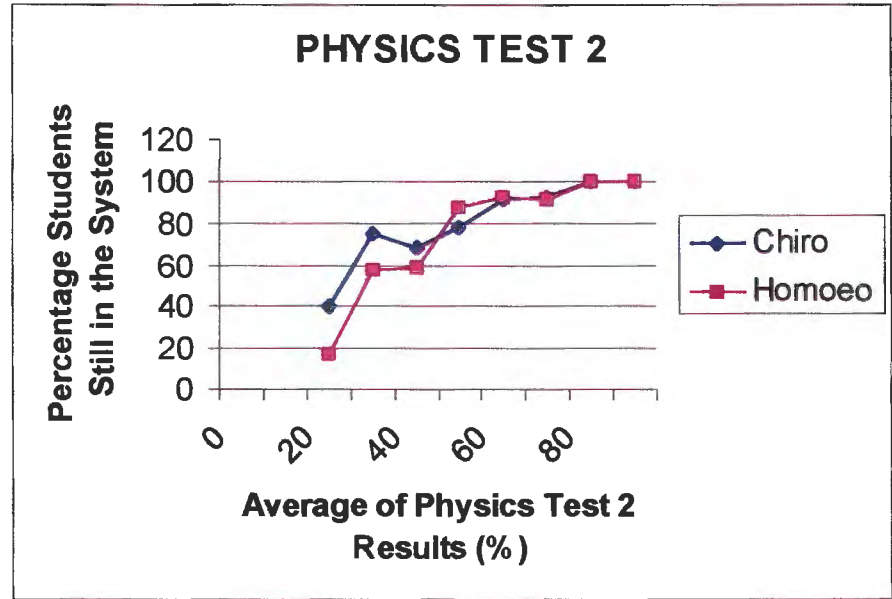


From Figure 49 there seems to be a relationship between performance in the second physics test and students who had to discontinue their studies because of academic exclusion at the end of the first year (students coded as 3). For both programmes, those students who had scored above 80% in this test had a 0% academic exclusion rate. The

graph indicates that of those students in the lower scoring brackets (< 50%), the chiropractic students had a lower academic exclusion rate than the homoeopathy students.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the second physics test and the percentage of students who remained in the system (successful students plus dropbacks).

FIGURE 50
PERCENTAGE FRESHMEN WHO REMAINED IN THE SYSTEM PER
AVERAGE PHYSICS TEST 2 RESULTS



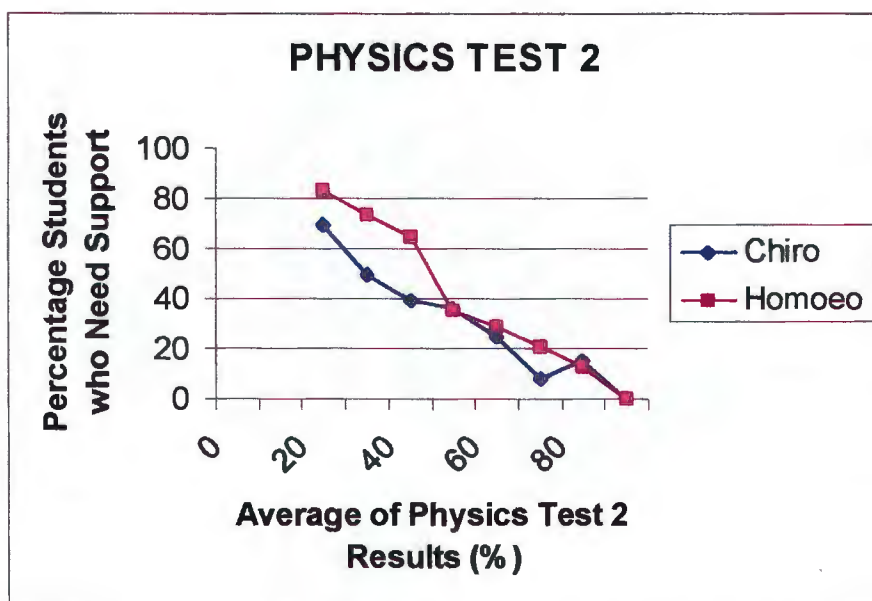
From Figure 50 there seems to be a relationship between performance in the second physics test and student retention at the end of the first year (students coded as 1 and 2). For both programmes the retention rate was 100% for students who had scored above 80%, and it was more than 90% for students who had scored above 60% in the second physics test. Of those students who had scored below 60% in this test, the chiropractic

students apparently had a slightly better retention rate than the homoeopathy students with similar scores.

The figure below will give an indication of a possible relationship between the average performance over the period 1989 to 1997 of all chiropractic and homoeopathy freshmen in the second physics test and the percentage of students who would require support in order to become successful at the end of the year (dropbacks plus academic exclusions).

FIGURE 51

**PERCENTAGE FRESHMEN WHO WOULD REQUIRE SUPPORT PER
AVERAGE PHYSICS TEST 2 RESULTS**



From Figure 51 there seems to be a relationship between performance in the second physics test and students who would need support during their first year of studies, i.e. those students coded as 2 (dropbacks) and 3 (academic exclusions). However, only those students who had scored above 90% in this test would appear to require no support, while for all students with scores below 90%, some form of support is indicated. The

graph indicates that for all levels of performance in the second physics test, fewer chiropractic than homoeopathy students needed support in order to become successful, i.e. fewer students became dropbacks or academic exclusions.

5.3.1.1 CONCLUSION

From the results reported in this section there seems to be a relationship between second test results and academic outcome at the end of the freshman year. The next section reports on the attempt that was made to utilize the second test results in the development of an estimated logistic regression model for the early identification of the student in need of support.

5.3.2 CAN A LOGISTIC REGRESSION MODEL THAT WILL IDENTIFY THE FRESHMEN AT RISK OF FAILURE BE ESTIMATED FROM TEST 2 RESULTS?

The purpose of this study was to investigate the predictive relationship between second test results and the probability that a student will require support in order to be successful at the end of the year (the probability that the student fails to succeed). All data between 1989 and 1995 inclusive were used in this analysis.

5.3.2.1 LIST OF VARIABLES

Dichotomous dependent variable:

Y = { 1 if not successful (students coded as 2, 3, 4)
 { 2 if successful (students coded as 1)

Independent variables:

X1 : Physiology Test 2 results
X2 : Anatomy Test 2 results
X3 : Biology Test 2 results
X4 : Chemistry Test 2 results
X5 : Physics Test 2 results

TABLE 19
PARAMETER ESTIMATES FROM THE OPTIMUM LOGISTIC REGRESSION
MODEL USING TEST 2 RESULTS AS PREDICTOR VARIABLES

Variable	$\hat{\beta}$	S.E. ($\hat{\beta}$)	Exp ($\hat{\beta}$)	P-values	95% C.I. for Exp ($\hat{\beta}$)		Order of Strength
Physiol 2	0.0329	0.0141	1.0334	0.0200	1.0052	1.0625	4
Anat 2	0.0668	0.0141	1.0690	0.0000	1.0398	1.0991	2
Biol 2	0.0809	0.0161	1.0843	0.0000	1.0506	1.1191	1
Chem 2	0.0404	0.0122	1.0412	0.0010	1.0165	1.0665	3
Physics 2	0.0206	0.0123	1.0208	0.0943	0.9965	1.0458	5
Constant	-11.7795	1.5507		0.0000			

FIGURE 52
ESTIMATED LOGISTIC REGRESSION MODEL USING TEST 2 RESULTS
AS PREDICTOR VARIABLES

From Table 19 the estimated logistic regression model is expressed as shown below:

$$\Pr(Y = 1) = \frac{1}{1+e^{-Z}}$$

$Z = -11.8 + 0.03(\text{Physiol 2}) + 0.07(\text{Anat 2}) + 0.08(\text{Biol 2}) + 0.04(\text{Chem 2}) + 0.02(\text{Physics 2})$

Using the above equation, an estimation can be made of the **probability that Y = 1** (the probability that a student fails to succeed) for any given values of the variables Physiology

Test 2 results, Anatomy Test 2 results, Biology Test 2 results, Chemistry Test 2 results, Physics Test 2 results, for any specific student enrolled in the Departments of Chiropractic and Homoeopathy at the end of the first year of studies.

5.3.2.2 INTERPRETATIONS OF THE ESTIMATED LOGISTIC REGRESSION MODEL USING TEST 2 RESULTS AS PREDICTOR VARIABLES

Interpretations are given below on the basis of results obtained in Table 19.

The low level of a predictor variable contributes less than its high level to the probability of failure, $\Pr(Y = 1)$.

1. When the “Physiol 2” variable changes from low level to high level (when the score obtained in the second physiology class test decreases from $> 90\%$ to $< 9\%$), the likelihood of a student not being successful at the end of the first year increases by a factor 1.0334. The fact that the odds ratio is greater than 1 shows that the physiology second test result is a strong predictor variable that affects academic success at the end of the first year of studies.
2. When the “Anat 2” variable changes from low level to high level (when the score obtained in the second anatomy class test decreases from $> 90\%$ to $< 9\%$), the likelihood of a student not being successful at the end of the first year increases by a factor 1.0690. The fact that the odds ratio is greater than 1 shows that the anatomy second test result is a strong predictor variable that affects academic success at the end of the first year of studies.
3. When the “Biol 2” variable changes from low level to high level (when the score obtained in the second biology class test decreases from $> 90\%$ to $< 9\%$), the

likelihood of a student not being successful at the end of the first year increases by a factor 1.0843. The fact that the odds ratio is greater than 1 shows that the biology second test result is a strong predictor variable that affects academic success at the end of the first year of studies.

4. When the “Chem 2” variable changes from low level to high level (when the score obtained in the second chemistry class test decreases from $> 90\%$ to $< 9\%$), the likelihood of a student not being successful at the end of the first year increases by a factor 1.0412. The fact that the odds ratio is greater than 1 shows that the chemistry second test result is a strong predictor variable that affects academic success at the end of the first year of studies.
5. When the “Physics 2” variable changes from low level to high level (when the score obtained in the second physics class test decreases from $> 90\%$ to $< 9\%$), the likelihood of a student not being successful at the end of the first year increases by a factor 1.0208. The fact that the odds ratio is greater than 1 shows that the physics second test result is a strong predictor variable that affects academic success at the end of the first year of studies.

5.3.2.3 DIAGNOSTIC PROCEDURES

(1) The overall percentage of correct classification

The overall percentage of correct classification is 85.94%, a figure that indicates that the estimated logistic regression model is reliable.

(2) Observed significance levels or P-values for each variable

The ability of an independent variable to explain the variability in the dependent variable is significant if the associated P-value is less than the level of significance α . Table 19 shows that $p < 0.05$ for each of the following independent variables included in the optimum

logistic regression model: Physiol 2, Anat 2, Biol 2, Chem 2. This shows that 4 of the 5 variables that appear in the optimum logistic regression model have the capacity to account for the variability in the dependent variable Y. (Physics 2 is important at the $\alpha = 0.10$ level).

(3) Estimated standard errors

All estimated standard errors in Table 19 are small. This indicates that the estimated logistic regression model performs well.

(4) The proportion of change in the -2Loglikelihood statistic

The value of the -2Loglikelihood statistic at the beginning of the backward elimination procedure was 410. The value of the same statistic at the end of the procedure was only 213. The proportion of decrease is equal to $(197/410) \times 100\% = 48.05\%$. This large decrease in the value of the statistic shows that the optimum model is good.

(5) Normal probability plots for studentized, leverage, and deviance residuals.

FIGURE 53

NORMAL P-PLOT OF STUDENTIZED RESIDUALS

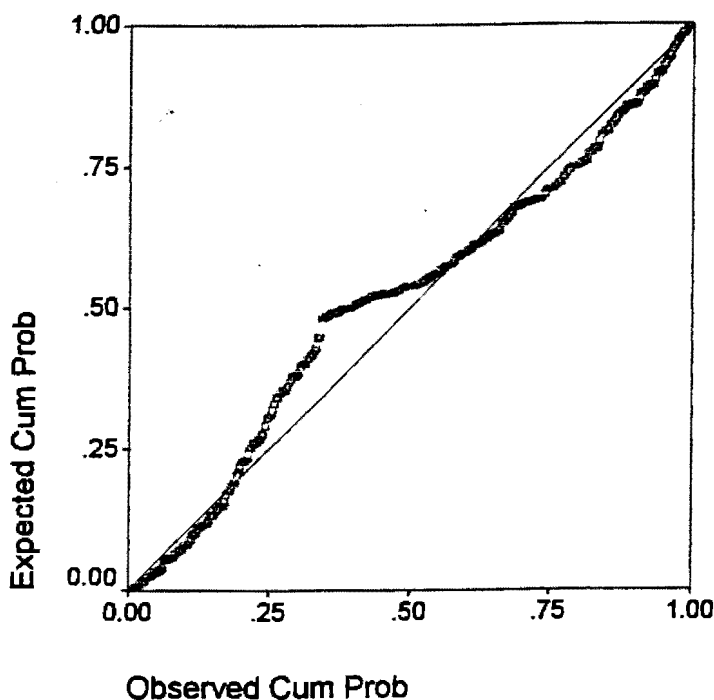


FIGURE 54
NORMAL P-PLOT OF LEVERAGE

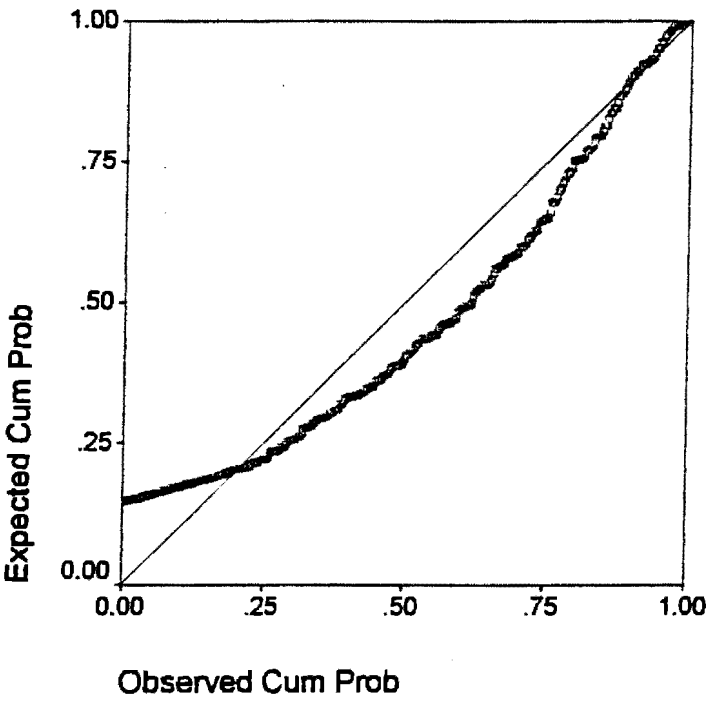
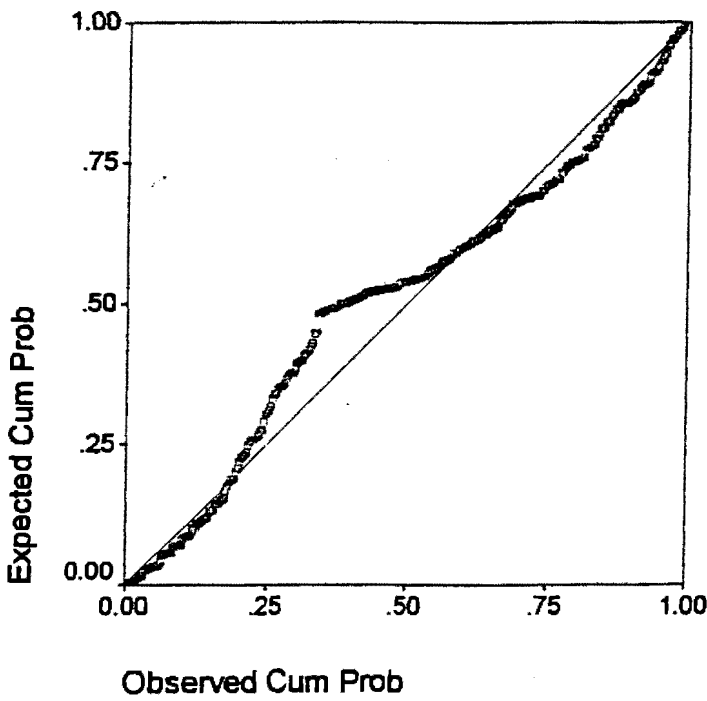


FIGURE 55
NORMAL P-PLOT OF DEVIANCE



The normal probability plots shown for the residuals are fairly S-shaped. This indicates that the error terms are approximately distributed normally.

5.3.2.4 CONCLUSION

The different diagnostic procedures shown above confirm that the estimated logistic regression model fits the data well.

An apparently accurate predictive model was estimated from the second test results in physiology, anatomy, biology, chemistry and physics of all chiropractic and homoeopathy freshmen in the period 1989 to 1997 inclusive. As a predictive model developed from one set of data might not necessarily fit a different set of data, this model was also validated on a different set of data.

5.3.3 CAN A LOGISTIC REGRESSION MODEL ESTIMATED RETROSPECTIVELY FROM TEST 2 RESULTS BE USED FOR THE EARLY IDENTIFICATION OF FUTURE AT RISK FRESHMEN?

In this section the logistic regression model estimated retrospectively from second test results was validated on the data from 1996 and 1997 in order to determine whether the model could be used for the early identification of future at risk freshmen.

In the figure below the ability of the logistic regression model to correctly identify $Y = 1$ (students not successful and therefore in need of support) is presented.

FIGURE 56

SENSITIVITY OF THE LOGISTIC REGRESSION MODEL ESTIMATED RETROSPECTIVELY FROM TEST 2 RESULTS

$$\begin{aligned}
 \text{Percentage of correct predictions} &= \frac{\text{Number correctly identified as not being successful}}{\text{Total number actually not being successful}} \times 100\% \\
 \text{(Sensitivity)} &= 24 / 36 \times 100\% \\
 &= 66.67 \%
 \end{aligned}$$

According to Hosmer & Lemeshow (1989) it is generally assumed that if the estimated probability of the event occurring is less than 0.5, then it is predicted that the event will not occur. An estimated probability of more than 0.5 will, on the other hand, lead to a

prediction that the event will occur. In the case of the research reported here, and for the sake of increasing the screening ability of the predictive model, an arbitrary increase of the cut-off estimated probability of the event occurring from 0.5 to 0.65, thus correctly classifies a further 5 of these at risk students. The sensitivity of the predictive model thus increases:

$$\begin{aligned}\text{Sensitivity} &= 29 / 36 \times 100\% \\ &= 80.56\%\end{aligned}$$

$$\begin{aligned}\text{False negative (Type I error)} &= 4 / 28 \times 100\% \\ &= 14.29\%\end{aligned}$$

False positive (Type II error)

$$\begin{aligned}\text{With estimated probability} = 0.5 &= 12 / 36 \times 100\% \\ &= 33.33\%\end{aligned}$$

$$\begin{aligned}\text{With estimated probability} = 0.65 &= 7 / 36 \times 100\% \\ &= 19.44\%\end{aligned}$$

In the figure below the ability of the logistic regression model to correctly identify the proportion of successful students is reported.

FIGURE 57

**SPECIFICITY OF THE LOGISTIC REGRESSION MODEL ESTIMATED
RETROSPECTIVELY FROM TEST 2 RESULTS**

$$\begin{aligned}
 \text{Specificity} &= \frac{\text{Number correctly identified as being successful}}{\text{Total number actually being successful}} \times 100\% \\
 &= 49 / 53 \times 100\% \\
 &= 92.44\%
 \end{aligned}$$

The results indicate that only 4 freshmen who were predicted as being successful actually did not pass at the end of the first year.

5.3.3.1 CONCLUSION

The logistic regression model developed retrospectively and validated on a new set of data (1995 and 1996) delivered strong support for the use of second test results for the identification of the at risk chiropractic and homoeopathy freshmen. The first and second test results were also subjected to discriminant analysis in order to further investigate the ability of test results to differentiate between successful students and students who would need support in order to be successful. The next section reports on these findings.

5.4 STUDY 4 : DISCRIMINANT ANALYSIS

The logistic regression analyses reported in the previous sections provided strong indications that first as well as second test results were useful tools for the early identification of the freshmen in need of support. In order to put the possible relationship between early assessments in the freshman year and academic outcome at the end of the year further to the test, the same data were subjected to discriminant analyses.

5.4.1 CAN DISCRIMINANT ANALYSIS PROCEDURES BE UTILIZED TO DIFFERENTIATE BETWEEN SUCCESSFUL AND UNSUCCESSFUL FRESHMEN ON THE BASIS OF THEIR TEST 1 RESULTS?

The purpose of this study was to investigate the possibility that first test results could be used to make a distinction between those students who would be successful and those students who would require institutional support in order to be successful at the end of the first year of studies in chiropractic and homoeopathy. All data between 1989 and 1995 inclusive were used in this analysis.

5.4.1.1 LIST OF VARIABLES

Grouping variable:

Y = { 1 if not successful (students coded as 2, 3, 4)
 { 2 if successful (students coded as 1)

Predictor variables:

- X1: Physiology Test 1 results
- X2: Anatomy Test 1 results
- X3: Biology Test 1 results
- X4: Chemistry Test 1 results
- X5: Physics Test 1 results

A stepwise discriminant analysis using the Wilks' Lambda procedure was performed on these variables. The most parsimonious model excluded the Physics Test 1 results. The other four predictive variables were all statistically significant in determining group membership.

TABLE 20

**STRUCTURE MATRIX OF FIRST TEST RESULTS USED AS PREDICTOR
VARIABLES TO DETERMINE GROUP MEMBERSHIP**

VARIABLE	COEFFICIENT	ORDER OF STRENGTH
Physiology Test 1 results	0.780	1
Biology Test 1 results	0.763	2
Anatomy Test 1 results	0.646	3
Chemistry Test 1 results	0.560	4

Table 20 indicates that the Physiology Test 1 result is the most influential variable responsible for first year success or failure.

In order to build the best possible model for classifying new cases in the future, the classification into the two groups of the grouping variable was conducted both on all the original cases, as well as on cross-validated cases by means of the leave-one-out method.

TABLE 21

**CLASSIFICATION RESULTS OF DICRIMINANT ANALYSES WITH FIRST
TEST RESULTS USED AS PREDICTOR VARIABLES**

			Predicted Group Membership		
STATPRED			1.00	2.00	Total
Original	Count	1.00	114	32	146
		2.00	41	190	231
	%	1.00	78.1	21.9	100
		2.00	17.7	82.3	100
Cross-validated	Count	1.00	111	35	146
		2.00	43	188	231
	%	1.00	76.0	24.0	100
		2.00	18.6	81.4	100

Table 21 indicates:

Usual (original) classification

Of the 146 students who were not successful, 114 (or 78.1%) are correctly classified into Group 1, and 32 (or 21.9%) are misclassified.

For the successful group, 190 students (or 82.3%) are correctly classified and 41 (or 17.7%) are misclassified.

Overall 80.6% of the students are classified correctly.

Cross-validated classification

Of the 146 students who were not successful, 111 (or 76.0%) are correctly classified into Group 1, and 35 (or 24.0%) are misclassified.

For the successful group, 188 students (or 81.4%) are correctly classified and 43 (or 18.6%) are misclassified.

Overall 79.3% of the students are classified correctly.

In discriminant analysis, a linear combination of the predictor variables is formed, and serves as a basis for assigning cases to groups. In this study, the following discriminant function was estimated:

FIGURE 58

DISCRIMINANT ANALYSIS MODEL USING TEST 1 RESULTS AS PREDICTOR VARIABLES

$$D = 0.054(\text{physiol1}) + 0.05(\text{anat1}) + 0.046(\text{biol1}) + 0.036(\text{chem1}) - 11.059$$

In the above equation, *physiol1*, *anat1*, *biol1*, and *chem1* are the four predictor variables in the study. *D* is the linear discriminant function that can be estimated for all 365 cases in this study. The resulting 365 estimated scores are then analyzed using a one-way Analysis of Variance. The Analysis of Variance procedure is used to test the null hypothesis that there is no significant difference between the two groups of students with respect to the 365 estimated discriminant function scores.

5.4.1.2 DIAGNOSTIC PROCEDURES

1. Eigen Values

The Eigen value (0.758) is fairly large.

2. Wilks' Lambda

Wilks' Lambda is 0.569 indicating that almost 60% of the variance is not explained by group differences. The p-value associated with the Wilks' Lambda statistic is 0.000, thus smaller than $\alpha = 0.01$. This shows that the criterion used to define group membership is objective.

3. Percentage of correct classification

The percentage of correct classification is $\geq 75\%$.

5.4.1.3 CONCLUSION

The different diagnostic procedures shown above confirm that the estimated discriminant analysis model fits the data quite well.

An apparently accurate predictive model was estimated from the first test results in physiology, anatomy, biology and chemistry. This model gave strong support to the use of first test results for the early identification of the at risk chiropractic and homeopathy freshmen. The possibility of utilizing second test results for this purpose was also investigated by means of discriminant analysis. The next section reports on the findings.

5.4.2 CAN DISCRIMINANT ANALYSIS

PROCEDURES BE UTILIZED TO DIFFERENTIATE BETWEEN SUCCESSFUL AND UNSUCCESSFUL FRESHMEN ON THE BASIS OF THEIR TEST 2 RESULTS?

The purpose of this study was to investigate the possibility that second test results could be used to make a distinction between those students who would be successful and those students who would require institutional support in order to be successful at the end of the first year of studies in chiropractic and homoeopathy. All data between 1989 and 1995 inclusive were used in this analysis.

5.4.2.1 LIST OF VARIABLES

Grouping variable:

Y = { 1 if not successful (students coded as 2, 3, 4)
 { 2 if successful (students coded as 1)

Predictor variables:

X1: Physiology Test 2 results
X2: Anatomy Test 2 results
X3: Biology Test 2 results
X4: Chemistry Test 2 results
X5: Physics Test 2 results

A stepwise discriminant analysis using the Wilks' Lambda procedure was performed on these variables. The most parsimonious model excluded the Physics Test 2 results. The other four predictive variables were all statistically significant in determining group membership.

TABLE 22

**STRUCTURE MATRIX OF SECOND TEST RESULTS USED AS PREDICTOR
VARIABLES TO DETERMINE GROUP MEMBERSHIP**

VARIABLE	COEFFICIENT	ORDER OF STRENGTH
Biology Test 2 results	0.783	1
Physiology Test 2 results	0.744	2
Anatomy Test 1 results	0.669	3
Chemistry Test 1 results	0.449	4

Table 22 indicates that the Biology Test 2 result is the most influential variable responsible for first year success or failure.

In order to build the best possible model for classifying new cases in the future, the classification into the two groups of the grouping variable was conducted on all the original cases, as well as on cross-validated cases by means of the leave-one-out method.

TABLE 23

**CLASSIFICATION RESULTS OF DISCRIMINANT ANALYSES WITH
SECOND TEST RESULTS USED AS PREDICTOR VARIABLES**

			Predicted Group Membership		
STATPRED			1.00	2.00	Total
Original	Count	1.00	110	16	126
		2.00	40	190	230
	%	1.00	87.3	12.7	100
		2.00	17.4	82.6	100
Cross-validated	Count	1.00	109	17	126
		2.00	44	186	230
	%	1.00	86.5	13.5	100
		2.00	19.1	80.9	100

Table 23 indicates:

Usual (original) classification

Of the 126 students who were not successful, 110 (or 87.3%) are correctly classified into Group 1, and 16 (or 12.7%) are misclassified.

For the successful group, 190 students (or 82.6%) are correctly classified and 40 (or 17.4%) are misclassified.

Overall 84.3% of the students are classified correctly.

Cross-validated classification

Among the 126 students who were not successful, 109 (or 86.5%) are correctly classified into Group 1 and 17 (or 13.5%) are misclassified.

For the successful group, 186 students (or 80.9%) are correctly classified and 44 (or 19.1%) are misclassified.

Overall 82.9% of the students are classified correctly.

In discriminant analysis, a linear combination of the predictor variables is formed, and serves as a basis for assigning cases to groups. In this study, the following discriminant function was estimated:

FIGURE 59

DISCRIMINANT ANALYSIS MODEL USING TEST 2 RESULTS AS PREDICTOR VARIABLES

$$D = 0.032(\text{physiol2}) + 0.059(\text{anat2}) + 0.072(\text{biol2}) + 0.03(\text{chem2}) - 9.898$$

In the above equation, *physiol2*, *anat2*, *biol2*, and *chem2* are the four predictor variables in the study. *D* is the linear discriminant function that can be estimated for all 320 cases in this study. The resulting 320 estimated scores are then analyzed using a one-way Analysis of Variance. The Analysis of Variance procedure is used to test the null hypothesis that there is no significant difference between the two groups of students with respect to the 320 estimated discriminant function scores.

5.4.2.2 DIAGNOSTIC PROCEDURES

1. Eigen Values

The Eigen value (0.816) is fairly large.

2. Wilks' Lambda

Wilks' Lambda is 0.551 indicating that more than 50% of the variance is not explained by group differences. The p-value associated with the Wilks' Lambda statistic is 0.000, thus smaller than $\alpha = 0.01$. This shows that the criterion used to define group membership is objective.

3. Percentage of correct classification

The percentage of correct classification is $\geq 75\%$.

5.4.2.3 CONCLUSION

The different diagnostic procedures shown above confirm that the estimated discriminant analysis model fits the data quite well.

An apparently accurate predictive model was estimated from the second test results in physiology, anatomy, biology and chemistry. This model gave strong support to the use of second test results for the early identification of the at risk chiropractic and homoeopathy freshmen.

5.5 SUMMARY AND CONCLUSION

In this chapter the problem of attrition in the first three years of the six-year chiropractic and homeopathy programmes was investigated retrospectively. Once it was established that a serious problem existed in both departments and that the biggest problem existed in the first year of studies, the study was confined to attempts at identifying the freshman at risk of failure at an early enough stage for remedial/support measures to still be effective in reducing attrition rates. Firstly, investigations were undertaken to establish whether a relationship could be demonstrated between first test results and academic outcome at the end of the year and also between second test results and academic outcome at the end of the year. Subsequent to that, logistic regression as well as discriminant analyses were performed on the data using first test results and second test results as predictor variables to build models for the early identification of the freshmen at risk of failure. In the next chapter the data reported above will be discussed.

CHAPTER SIX

DISCUSSION

As almost all tertiary institutions around the world appear to have a significant proportion of students who discontinue their studies, especially so in the early years, the academic success and retention of students at tertiary institutions should be the primary concerns of educational managers and researchers, particularly so in an era of declining resources. Due to the increased pressure on institutions to be accountable and financially efficient, the need to quantify, understand and minimize the phenomenon of attrition becomes more urgent every day. Educational management principles thus dictate that every tertiary institution should quantify its problem of attrition per programme, identify the student at risk, and implement measures to retain as many students as possible by supporting them to become successful in an atmosphere of academic quality.

6.1 STUDY 1 : THE CURRENT REALITY

The initial step in institutional research into the problem of attrition should be an in-depth investigation into student numbers and rates of attrition in every department in the tertiary institution. The present *ex post facto* research study explored the problem of student attrition by using as an example the first three years of study in the two six-year programmes of chiropractic and homoeopathy as offered at Technikon Natal in South Africa.

Of interest was the fact that the learning programmes for the first two years and most of the third year were identical, the so-called pre-professional stage of the programmes (see outline of the programmes in Section 4.3.2). However, it was observed that, whilst all the students shared the same classrooms and were treated as a homogeneous group by

lecturers in the basic sciences, definite differences emerged between the chiropractic and homoeopathy student groups.

Due to shared laboratory facilities the two programmes were limited to a total of 66 places for new students per year; thus theoretically 33 places per programme. Table 1, however, indicates that, as from 1991 onwards, a consistently larger first-year group registered for chiropractic with an overall decline in the numbers of new homoeopathy students. Table 1 thus indicates that the Department of Homoeopathy never managed to fill its allocated places between 1992 and 1997 and, in fact, that the number of homoeopathy first year students decreased dramatically from 30 in 1992 to 17 in 1997. Possible reasons for the observed decline in numbers should be researched in order to correct existing problems. If it then transpires that the student demand for homoeopathy training is lower than that for chiropractic, more places might have to be made available to the Department of Chiropractic in order to ensure that the pre-professional years remain cost-efficient. One aspect that needs to be urgently investigated is the possibility that the declining numbers in the Department of Homoeopathy might be an indication that, generally, not enough “quality” students apply for entry into this programme.

6.1.1 HOW SERIOUS IS THE PROBLEM OF ATTRITION?

In order to quantify the problem of attrition per year of study, the academic status of each student at the end of the first, second and third years of study was coded as either:

(1) Successful (having passed all subjects in one year of study), (2) Drop-back (having failed one or more subjects and falling behind his cohort), (3) Academic dismissal, or (4) Voluntary withdrawal.

In comparing the percentage first year students in each of the two groups who performed well and were academically successful (coded as 1) (Table 4), it became apparent that both programmes had a low average success rate (66% for chiropractic and 55% for

homoeopathy). It also became apparent that a difference existed in the success rates of the chiropractic and homoeopathy first year students. This difference between the performance of the two groups of first year students is illustrated in Figure 5 which shows that on average over the years investigated, the chiropractic students tended to perform better than the homoeopathy students. Table 4 also indicates that this trend continued into the second and third years of study with, on average, a larger percentage of chiropractic students being successful at the end of both these years.

Figure 5 indicates that the chiropractic students apparently started outperforming the homoeopathy students as from 1991. Of interest is the fact that this difference in performance occurred from approximately the same year that the decline in the homoeopathy first year numbers became apparent (Table 1). The lower percentage of successful homoeopathy students when compared to their classmates in chiropractic might thus be linked to the possibility put forward earlier that not enough “quality” students might have applied to study homoeopathy during those years. This possibility should be further investigated.

In 1997 (Figure 5) chiropractic showed a lower than usual percentage of successful students and also a lower percentage of successful students than did homoeopathy for the same year. This fact is important to note as 1997 was the start of an affirmative action policy by the Department of Chiropractic. What is also important is the fact that every one of the African students who enrolled in 1997 was classified as an academic exclusion at the end of the first year due to poor academic performance. An objective model whereby the student at risk of academic failure could have been identified early enough to still have time for appropriate remedial action might have saved many of these students from being “lost” to the programmes and to the institution.

The percentages of successful students per year as well as per group, certainly constitute important information, because these tables also indicate that a large number of students were not successful. Table 4, for example, indicates that on average only 66% of chiropractic and 55% of homoeopathy students were successful at the end of their first

year of study. This average percentage of successful students drops to 55% for chiropractic and to 42% for homoeopathy at the end of the second year. At the end of the third year of studies only 46% of the initial chiropractic intake and only 39% of the initial homoeopathy intake were successful. These percentages indicate students who did not fail any year and who completed their three years of study in the minimum period.

The results of the present study thus indicate a high rate of attrition for both programmes under investigation. Although published figures are almost impossible to compare due to various classifications of groups and different reporting formats, other researchers from around the world have also indicated the existence of serious problems of student attrition/discontinuation (e.g. Anderson *et al.* 1994 ; Nnodim 1994; Johnson & Buck 1995; Ayaya 1996; Simpson & Budd 1996; Yorke 1998). Of importance is the fact that the problem of student attrition has apparently not improved over the past 86 years. Summerskill (1965) in his early review of 35 studies of student attrition published between 1913 and 1962 reported that colleges in the USA lost about half of their student intake during the four years at college and that only 40% of students graduated on schedule. Campbell and Dickson (1966) reported on a 10-year review of the literature, that 44% of all students who were admitted to baccalaureate nursing programmes in the USA failed to complete their programme successfully.

Not many figures on attrition appear to be available from South Africa, except from the faculties of engineering where serious concern was expressed. For example, Todd and Raubenheimer (1994) showed that, on average, only 4% of the students who registered for an engineering degree at the Rand Afrikaans University in South Africa between 1982 and 1986, completed their degree in the minimum period of 4 years. A staggering 72.3% of the students never completed their engineering programmes.

As far as medical schools are concerned, most of the data on attrition emanate from the USA. Unfortunately data from the United States medical schools cannot be compared with those from South Africa. As explained before, in South Africa students are selected into medical schools and programmes such as chiropractic and homoeopathy straight

from school, but in the USA this only happens after completion of premedical (or pre-professional) studies. The academic careers of such older students who have already proven themselves in tertiary studies can therefore not be compared with the academic outcome of the school leavers. The only available published attrition figures from a medical school which also selects straight from school is the Lazin and Neunmann (1991) study from the Ben Gurion medical school in Beer Sheva in Israel. The authors indicated high noncompletion rates. Particularly for the period 1981-1983, 42.1% of their medical students were reported to be in academic difficulty.

In the present study only student success has so far been discussed. The main aim of the present research was, however, not the successful students, but those students who were at risk of failing and would thus increase the attrition rate. The question that has to be addressed is that if so few students were successful per year, what happened to the rest? Some of the students not coded as successful were obviously still in the system as drop-backs (those coded as 2), but others were "lost" (those coded as 3 and 4). Table 5 indicates that, at the end of the first year of study, on average as much as 23% of chiropractic and 27% of homoeopathy students were classified as either academic exclusions or voluntary withdrawals and therefore "lost" to the departments and to the institution. If this analysis is extended over the first three years of study, Table 5 shows that a staggering 35% of the chiropractic intake and 43% of the homoeopathy intake were "lost" by the end of the first three years.

The above percentages need to be separated into those students that left because of academic reasons (coded as 3) and those that left voluntarily (coded as 4). Table 5 indicates that on average 23% of students in both the chiropractic and homoeopathy programmes were excluded for academic reasons by the end of the third year, whereas more students left the homoeopathy programme voluntarily than those leaving the chiropractic programme voluntarily. At the end of three years, an average of 12% of the chiropractic students had withdrawn of their own accord, as opposed to 19% of the homoeopathy students. Approximately half of the voluntary withdrawals in each group occurred as early as the first year of study whilst the other half occurred during the

second and third years. It is very difficult to establish retrospectively why students withdrew voluntarily from a programme. In some cases students had financial or health problems and in some cases they decided that they had made a mistake in their choice of profession. Some of the voluntary withdrawals might also have been academically linked in that students realized that they had no hope of passing a particular year. A prospective study should be planned in an attempt to determine the major reasons for voluntary withdrawals in order to assist selectors in their very difficult task. Exit interviews, and/or follow-up questionnaires might shed some light on withdrawal behaviour.

Until firm answers can be found as to the possible reasons for voluntary withdrawals, there is not much that a department or an institution can do to try and retain those students who leave of their own free will. Of paramount importance from an institutional viewpoint, however, should be those students who are “lost” because they have experienced academic difficulties, as such students might be “saved” by timely identification, intervention and support. These students represent considerable financial and other resource loss to both the institution and to themselves. As indicated by Table 5, on average 23% of the annual intake from both groups faced academic exclusion somewhere in their first three years of study.

The results of the present study (Table 5) implicate academic difficulty as the most important reason for attrition. This finding is in accord with the reported results of authors such as Johnson and Buck (1995), Simpson and Budd (1996), and Huff and Fang (1999).

The results of the research reported here are not easily comparable to those from the reviewed publications. As mentioned before, researchers tended to use a variety of categorizations for students who discontinued their studies. Unfortunately, inadequate attention to definition has often led researchers to lump together, under the categorization of dropout, forms of leaving behaviour that are very different in character. The majority of researchers have thus failed to distinguish between attrition resulting from academic reasons and attrition resulting from voluntary withdrawal. The most important omission,

however, is the fact that most of the researchers did not indicate the very important (to the institution) drop-back group of students, in other words those students who were still in the system, but who had fallen behind their peers to graduate late (or not at all). Table 5 indicates quite clearly that this group of students should receive urgent remedial attention, as only an average of 48% of the students who became drop-backs at the end of their first year of study remained in the system till the end of the third year. The other 52% were still “lost” during the second and third years of study. The group of drop-backs therefore also requires urgent remedial attention.

The large numbers of drop-backs, in addition to the academic exclusions indicated above, must lead to the conclusion that the problem of attrition in the chiropractic as well as in the homoeopathy programmes is serious enough for both departments to be seen as “high risk” departments.

6.1.2 WHEN IS THE RISK OF ATTRITION THE HIGHEST?

Contrary to a more dispersed pattern of voluntary withdrawals, Table 5 indicates that the majority of academic exclusions, i.e. $17/23 = 75\%$ for chiropractic and $19/23 = 83\%$ for homoeopathy, occurred in the first year of study. This finding is supported by the results of other researchers such as Baumgart and Johnstone (1977), Pantages and Creedon (1978), Johnes and Taylor (1989), Young (1989), Anderson *et al.* (1985), Anderson *et al.* (1994), Johnson and Buck (1995), Simpson and Budd (1996), and Cariaga-Lo *et al.* (1997), who all indicated that the highest risk of academic failure occurred in the first year of study.

It is argued that in an investigation of “at risk” students, not only the group classified as “academic exclusions” should be seen as important. In reality the number of drop-backs per year should be added to the academic exclusions, as both these groups of students are

not coping with their tertiary studies. In the chiropractic and homoeopathy programmes the failure of a single extra subject in the first year of study could mean the difference between becoming a drop-back and facing academic exclusion which occurs if three (or more) first-year subjects are failed (see pass requirements in Section 4.3.2). A student failing two first-year subjects could therefore continue with his studies whilst a student failing three first-year subjects is excluded from future registration. The drop-back students also represent a resource burden as they add extra year/s to their studies. As mentioned in Section 6.1.1 above, it was observed that on many occasions a student who had become a drop-back in the first year was lost to the system during the subsequent two years. Table 7 indicates that, for the period 1989-1996, only 48% (44% chiropractic and 51% homoeopathy students) of the 70 students who were classified as drop-backs in their first year, remained in the system.

Table 7 indicates that more homoeopathy (51%) than chiropractic (44%) first-year drop-backs became future drop-backs. Of interest to note is the fact that more of the chiropractic first-year drop-backs faced future academic exclusions (37%), whilst 30% of the homoeopathy first-year drop-backs withdrew voluntarily. The fact that chiropractic students failed more often in the second and third years of study than the homoeopathy students did could be partly explained by the fact that the chiropractic department has higher pass and sub-minimum standards on common subjects (see pass requirements in Section 4.3.2). The phenomenon that cannot be explained away easily, though, is the high percentage of voluntary withdrawals from students who were potentially successful. This information supports the data in Table 5, which indicate that more than half of the homoeopathy voluntary withdrawals happened after the first year of study. One would have expected potentially successful students to make up their minds during their first year of study as to whether they wanted to continue studying towards that career or not. This finding supports the earlier suggestion that a climate study should be undertaken for the homoeopathy department as this might also shed light on possible causes of the high student attrition through this route.

Table 6 shows the average percentage of “at risk” students calculated by adding the numbers of drop-back students (coded as 2) to the numbers of students who become academic exclusions (coded as 3). On average, for the years investigated the homoeopathy programme had a considerably larger percentage of first year students who were experiencing academic difficulties (37% as opposed to 28% respectively). No such difference between the groups could be demonstrated in total over the first three years of study. It thus appears as though second and third year homoeopathy students did not experience serious academic difficulties. The chiropractic programme, on the other hand, still showed a number of students who either became drop-backs or who faced academic exclusion during the next two years of study. There could be a number of possible reasons for this phenomenon such as the fact previously mentioned that although the students in the two groups shared the same subjects, chiropractic had higher pass requirements in a number of these subjects (see pass requirements in Section 4.3.2). In Diagnostics II and III, for example, the chiropractic students were expected to have a subminimum of 50% in all sections of the assessments whilst the homoeopathy department only required a 40% subminimum from their students.

The results of this study have indicated clearly that the first year students in both programmes were at the greatest risk of failing. Although students in later years still became drop-backs or academic exclusions, the freshmen year was indicated as the greatest academic hurdle. It therefore becomes essential in the future to address the question of whether or not the academic threshold on entry is too low and allows too many underequipped or underprepared students into the programmes.

This descriptive study has indicated very clearly that the numbers of students “lost” from both the chiropractic and homoeopathy programmes are unacceptably high. It has also indicated that the first year of study is the most dangerous time for these students. Urgent measures are therefore required to identify and retain “at risk” freshmen. In order to provide support to freshmen experiencing academic difficulties, an objective method is required whereby freshmen at risk of failing could be identified at an early enough stage

of the year for support programmes to be instituted and to still have an effect on student retention rates.

Student attrition rates in the two programmes under investigation in this research, as well as around the world, remain unacceptably high. As student attrition rates have such serious financial implications for a tertiary institution, the temptation inevitably exists to select only those students that will have a fair chance of being successful. In the medical field, which includes chiropractic and homoeopathy, selection policies must, however, be based on specific student characteristics that will ensure empathetic and caring practitioners. In South Africa, selection policies must also attempt to redress imbalances of the past and thus be geared to providing access to large numbers of black students who were previously academically disadvantaged. The fact that attrition rates are even higher for black students has been indicated very clearly in the literature (McManus *et al.* 1996; Collins *et al.* 1997; Koenig *et al.* 1998; Tekian 1998; Taylor & Rust 1999). It is thus imperative that selection policies be accompanied by a policy of support to academically “at risk” students.

It is very important that tertiary institutions understand and accept their social obligations not only as a gesture, but also in the full support of all students that they register into a programme(s). They must also understand and be able to quantify the financial cost of their selection policies. This can only be done efficiently if the institution is able to determine as early as possible how many students would need to receive support. At the same time the “at risk” freshmen will need to be provided with the necessary support mechanisms at an early enough stage of the first year in order for such remedial/support measures to still have the desired effect and prevent the student from failing. The early identification of the student in need of support is thus essential.

According to the theoretical models of attrition (e.g. Tinto 1975; Tinto 1997; Johnson & Buck 1995), characteristics that a student brings with him/her to the tertiary institution will interact with institutional characteristics and together they will determine a student's academic integration and commitment to graduation. Academic integration can only be

measured once a student has been assessed at a tertiary institution and for a freshman, the various assessments of the first year will thus be the first reasonably objective measure of academic integration. The utilization of such tests for the development of an early warning system could therefore be of great value.

6.2 STUDY 2 : TEST 1 RESULTS

6.2.1 IS THERE A RELATIONSHIP BETWEEN RESULTS OBTAINED IN THE FIRST TESTS AND SUCCESS OR FAILURE AT THE END OF THE FIRST YEAR OF STUDIES?

Despite the fact that authors from as early as 1950 (see Pantages & Creedon 1978) have reported indications of a possible relationship between first semester college grades and attrition, and the fact that more recent publications (Van Overwalle 1989; Croen *et al.* 1991) have also reported such relationships, very little actual research exists in this area.

As a first step in the present research an attempt was made to determine whether a relationship between first test results and success or not at the end of the first year of studies could be indicated for chiropractic and homoeopathy freshmen. In order to do so the percentages of students per coding category (1, 2 or 3) were calculated per first year subject for each level of academic performance in the first test series. The results are presented in Tables 8 to 12 and Figures 6 to 25. For example, in each of these Tables, the block "Students with 50-59%" would indicate the coded outcome at the end of the first year for all students who obtained between 50% and 59% in the first test in that particular first year subject.

From these results it has become clear that a very definite link exists between first test results and success or failure at the end of the first year of studies. Of particular interest to this researcher was also the clear relationship that emerged between first test results and those freshmen who would need support in order to be successful (Figures 9, 13, 17, 21, 25).

The first test results in physiology (Table 8, Figures 6 to 9), anatomy (Table 9, Figures 10 to 13), biology (Table 10, Figures 14 to 17) and chemistry (Table 11, Figures 18 to 21) emerged as particularly good indicators of outcome at the end of the first year. Strong relationships could be demonstrated between these test results and all four the outcomes investigated, namely success (students coded as 1), academic exclusion (students coded as 3), retention (students coded as 1 and 2), and support required to ensure success (students coded as 2 and 3). Although some association was also apparent between first test performance in physics and outcome at the end of the first year of studies (Table 12, Figures 22 to 25), this association appeared to be weaker than with the other four first year subjects discussed above. Figure 22 indicates, for example, that high first-test scores in physics did not ensure academic success at the end of the first year. Over all the years under investigation, a total of only 7 homoeopathy freshmen that had scored above 90% in this test passed all their subjects at the end of the first year. A similar trend was apparent for the chiropractic freshmen. Figure 23 also indicates that, for both programmes, even students who had scored above 90% in the first physics test still became academic exclusions at the end of the first year. The fact that students with high first test scores in physics could still be in serious academic difficulty would need to be further explored. This phenomenon might be an indication that the standard of physics as assessed in the first test was lower than that of the other first year subjects, or that the subject matter assessed in the first test was not relevant to the rest of the first year.

However, a strong relationship emerged between performance in the first physics test and student retention at the end of the first year (Figure 24) as, for both programmes, those freshmen who had scored above 70% in this test showed a retention rate of more than 90%. One possible reason for this might lie in the fact that physics is one of the few

"minor" subjects in these two programmes and might thus be carried over and taken in the second year together with a full second year load. All the other subjects are pre-requisites to a number of second year courses and failure in such a subject invariably means the addition of an extra year to the study period, which might in turn have an effect on voluntary withdrawal decisions.

As with performance in the first test for the other four first year subjects (Figures 9, 13, 17, 21) Figure 25 also indicates a relationship between performance in the first physics test and those students who would require support in order to be successful at the end of the first year (students coded as 2 and 3). However, in contrast to the first test performances in the other subjects where the high-scoring students would require no support in order to be successful, the relationship with physics is not clear. Except for those homoeopathy freshmen who had scored above 90% in this test, it appears as though all other students might require support in order to be successful. This result is again an indication that, on average, scores in the first physics test might not be directly related to final outcome at the end of the first year.

Another important trend that emerged from this investigation was the fact that chiropractic students were apparently able to be successful and to need less support in order to be successful than homoeopathy students at the same first test performance. This phenomenon appears to be true for particularly first-test performances in physiology (Table 8, Figures 6 to 9), biology (Table 10, Figures 14 to 17), and chemistry (Table 11, Figures 18 to 21) and less obvious for anatomy (Table 9, Figures 11, 12) and physics (Table 12, Figures 23, 24). However, even for anatomy (Figures 10, 13) and physics (Figures 22, 25) it is apparent that chiropractic freshmen were more successful and needed less support than their homoeopathy classmates at the same level of first-test performance.

The fact that chiropractic students with lower first test results can still be successful at the end of the first year of studies needs further investigation. This result again ties in with previously reported observations and results that chiropractic students apparently

performed better than expected, or that homoeopathy students apparently performed worse than expected when compared to their classmates.

The investigations undertaken in this section of the research thus demonstrated the existence of a strong relationship between first test results and outcome at the end of the first year of studies. No direct comparisons of this observation could unfortunately be made with published studies as the available literature delivered no study attempting to demonstrate a direct relationship between first test results and success or failure at the end of the first year of tertiary studies. Only two studies could be found (Van Overwalle 1989; Croen *et al.* 1991) where this aspect was mentioned. Although Van Overwalle (1989) indicated that midterm results showed the strongest associations with academic performance in the first year (mean r 0.65), the predictor criteria investigated were not the actual midterm results scored by the students, but were the self-reported characteristics of the students and their social environment. These self-reported characteristics were then also correlated with actual grades at the end of the first year and not with outcome as in the present study. Although this result could thus not be directly compared with the results of the present study, the fact that students perceived their midterm results to be the best predictor of final grades was a very important finding.

Unfortunately the study of Croen *et al.* (1991) was also a performance-based study which used as criterion variables the actual grades scored in each subject at the end of the year. Of importance was the fact that the results showed very clearly that 'pervasive marginal performance' on third-month examinations in four required first-year medical courses was highly predictive of similar academic performance throughout the first and second years. Unfortunately no comparisons were thus possible with the present study. The Croen *et al.* (1991) study dealt with professional studies and thus with more senior students than the freshmen investigated in the present study, and their study therefore also dealt with different and more senior subjects.

The results discussed in this section of the present research gave an indication of the existence of a strong relationship between first test results and outcome at the end of the first year of studies.

6.2.2 CAN A LOGISTIC REGRESSION MODEL THAT WILL IDENTIFY THE FRESHMEN AT RISK OF FAILURE BE ESTIMATED FROM TEST 1 RESULTS?

As the high attrition rate of particularly first year students from tertiary institutions remains of serious concern, the development of a method whereby the freshmen who would need support in order to be successful could be identified within a couple of months must be regarded as a matter of high priority. The purpose of the present study was thus to investigate the predictive relationship between first test results and outcome at the end of the first year of studies in chiropractic and homoeopathy.

The most parsimonious logistic regression model developed by means of backward elimination for the estimation of the probability that $Y = 1$ (the probability that the student fails to succeed) included four predictor variables (Table 13, Figure 26). The results of this study indicated that first test results in physiology, anatomy, biology, and chemistry discriminated well between non-successful and successful freshmen. The overall percentage of correct classification was 80.82%, which indicates that the estimated logistic regression model is reliable. Different diagnostic procedures (Figures 27 to 29) conducted on the prediction model indicated that the estimated logistic regression model fitted the data well.

It is of interest to note that first test results in physics did not survive the backward elimination process in the development of the logistic regression model discussed above. This result agrees with the trend that became apparent in Table 12 and Figures 22 to 25 as discussed in Section 6.2.1 where average first test results in physics over the years

investigated did not seem to have a strong relationship with outcome at the end of the first year of studies. For example, students who were in serious academic difficulty later in their first year were apparently still able to score high marks in the first physics test. This phenomenon would need to be further investigated. A search of the literature delivered no studies which used test results to develop models for the early identification of the freshmen at risk of failing and no comparisons with other results could thus be drawn.

The results reported here indicate that certain of the chiropractic and homoeopathy freshmen were at higher risk than others in that they would not successfully complete their first year of study. The results of the logistic regression analyses suggest that a reasonably accurate predictive model with an overall predictive accuracy of approximately 80.82% can be developed. An equation (Figure 26) based on first-test results in physiology, anatomy, biology and chemistry significantly discriminated between those freshmen who would require support in order to be successful, and those that would be successful at the end of the first year of studies. Compared to the successful students (coded as 1), the group of students who would require support (coded as 2 and 3) would have lower scores in the first tests of these four first-year subjects.

Cognisance was taken of the fact that an apparently accurate predictive model developed from one set of data might not necessarily fit a different set of data drawn from the same universe. The present estimated logistic regression model developed from the data of all chiropractic and homoeopathy freshmen who registered between 1989 and 1995 therefore had to be validated on another set of data from the chiropractic and homoeopathy students before it could be used as a tool for the early identification of the freshmen in need of support.

6.2.3 CAN A LOGISTIC REGRESSION MODEL ESTIMATED RETROSPECTIVELY FROM TEST 1 RESULTS BE USED FOR THE EARLY IDENTIFICATION OF FUTURE AT RISK FRESHMEN?

The estimated logistic regression model developed retrospectively from the first test results of all chiropractic and homoeopathy students who had registered between 1989 and 1995 (Table 13, Figure 26) showed a high overall predictive accuracy of 80.82% and was therefore reasonably reliable. However, before such a model could be used for the early identification of new freshmen who would need to be provided with institutional support in order to prevent their attrition, the model had to be validated. This was done by making use of the first-test results of all chiropractic and homoeopathy freshmen who registered in 1996 and 1997.

Figure 31 indicates that the model has a specificity of 59.26%. This implies that the model could only correctly identify approximately 60% of those freshmen that would be successful at the end of the first year. It is very interesting to note (Figure 31) that the specificity of the estimated model could be increased to 78.38% by omitting the 1996 chiropractic results. It appears as though the 1996 chiropractic group was yet another example of the chiropractic freshmen being able to succeed despite initial lower performances. The specificity of the estimated logistic regression model developed from first test results was only 17.65% for this one year of chiropractic freshmen. That implies that many students who were potential failures had managed to keep focussed in order to successfully complete the first year of studies despite initial lower test results. Possible contributing factors to this trend in the chiropractic programme need to be urgently investigated. Once identified, such factors could perhaps be usefully applied for the retention of other potentially “at risk” students.

The present research was, however, not primarily aimed at identifying the successful student, but was an attempt to identify those students who would need support in order to be successful. The sensitivity of the predictive model was therefore seen as of much more importance than its specificity. Figure 30 shows a very high sensitivity of 92.8%, which indicates that the model is able to identify most of the eventually non-successful students. The sensitivity can be increased to 97.62% by raising the cut-off estimated probability of the event occurring from 0.5 to 0.65 (Hosmer & Lemeshow 1989).

The only study which mentioned the percentage of “at risk” students that could be identified during the first year of study was the Croen *et al.* (1991) study mentioned before. Unfortunately no direct comparisons could be drawn with the results of the present research. As mentioned before, the Croen *et al.* (1991) study was conducted on first year medical students in the USA and therefore investigated the first year of professional studies and not first-time freshmen as the present study did. However, Croen *et al.* (1991) did report that their linear regression predictive model correctly identified 77% of all the students in the class who encountered serious academic problems during the first year of medical studies. The present validated predictive model developed from first test results was therefore superior to their model in that it was able to correctly identify more than 90% of the students in need of support.

As far as predictive errors are concerned, the model validation indicated a Type I (False negative) rate of 34.43% (Figure 30). This means that approximately 34% of the students who were actually successful at the end of the first year were predicted as being not successful. This cannot be seen as a serious predictive error. Table 4 indicates very clearly that in addition to the high attrition rate in the first year, a large percentage of chiropractic and homoeopathy freshmen were also not successful at the end of the next two years. In addition, Table 7 also indicates that of the students who became drop-backs in the first year of studies, on average another 26% became academic exclusions and 26% became voluntary withdrawals over the next two years. As the main aim of the predictive model discussed here is to identify those freshmen in need of support, it can only be to the benefit of those freshmen “overpredicted” as potentially non-successful to receive the extra support from the institution. For students who had perhaps performed better than

expected by sheer hard work, or some luck, to be singled out for extra support early in their studies might perhaps prevent their attrition in later years.

What is of great importance to this researcher is that the Type II error (false positive) of the predictive model is only 7.14% (Figure 30). If the cut-off estimated probability of the event occurring was increased from 0.5 to 0.65 (Hosmer & Lemeshow 1989) the Type II error can be reduced even further to a very low 2.38%. This means that only approximately 2% of the potentially “at risk” freshmen were missed by the predictive model.

The logistic regression model developed retrospectively from test one results could therefore be very useful for the early identification of the future at risk freshmen. The model is totally objective and students are classified according to their actual performance. Support measures supplied at such an early stage of the year could have a considerably impact on the attrition rate. This model could also be very useful to the institution for planning and budgeting purposes as a simple analysis very early in the year would indicate how many students were in need of institutional support in order to be successful at the end of the year. The cost implications of the required support could thus be accurately determined.

6.3 STUDY 3 : TEST 2 RESULTS

6.3.1 IS THERE A RELATIONSHIP BETWEEN RESULTS OBTAINED IN THE SECOND TESTS AND SUCCESS OR FAILURE AT THE END OF THE FIRST YEAR OF STUDIES?

The results discussed in Section 6.2 above indicated the existence of a strong relationship between first test results and outcome at the end of the first year of studies in chiropractic and homoeopathy. The estimated logistic regression model developed from the first test results could therefore be utilized for the early identification of the student in need of support. However, it would also be very useful for a head of department to know after the second test series which students would still be academically “at risk” and/or whether any support programmes instituted after the first test series had the desired effect.

A search of the available literature revealed no study that had demonstrated the existence of a relationship between second test results and outcome at the end of the first year of studies. In this section of the present research an attempt was thus firstly made to determine whether such a relationship existed and could be demonstrated for the chiropractic and homoeopathy programmes. In order to do so the percentages of students per coding category (1, 2 or 3) were calculated per first year subject for each level of academic performance in the second test series. The results are presented in Tables 14 to 18 and Figures 32 to 51. For example, in each of these Tables, the block “Students with 50-59%” would indicate the coded outcome at the end of the first year for all students who had obtained between 50% and 59% in the second test in that particular first year subject.

From these results it became clear that a very definite link exists between second test results and success or failure at the end of the first year of studies. Strong relationships

could be demonstrated between second test results in physiology (Table 14, Figures 32 to 35), anatomy (Table 15, Figures 36 to 39), biology (Table 16, Figures 40 to 43), chemistry (Table 17, Figures 44 to 47), physics (Table 18, Figures 48 to 51) and outcome at the end of the first year. These test results appeared to be good predictors of all four the outcomes investigated, namely success (students coded as 1), academic exclusion (students coded as 3), retention (students coded as 1 and 2), and support required to ensure success (students coded as 2 and 3). Contrary to the results discussed in Section 6.2.1 where it was indicated that the first test results in physics did not show strong associations with outcome at the end of the first year, no such trend emerged with the second physics test results.

Of particular interest to this researcher is again the very clear relationship that emerged between second test results in all five the first-year subjects and those freshmen who would need support in order to be successful at the end of the first year (Figures 35, 39, 43, 47, 51). Also contrary to the results discussed in Section 6.2.1 where it was indicated that, on average, scores obtained in the first physics test might not be directly related to outcome at the end of the first year, this anomaly was not apparent with the physics second test results. Figure 51 indicates a clear relationship between this result and those students who would need support in order to be successful. It must, however, be remembered that this section of the research (as also Section 6.2.1) made use of average test results as obtained over a number of years and that only trends could therefore be identified from these analyses. In order to obtain more “accurate” indications of the predictive value of individual subjects, logistic and/or discriminant analytical techniques that use actual results will have to be employed.

An important trend that (again) emerged from this section of the research was the recurrent theme of chiropractic students apparently being able to be more successful than the homoeopathy students with similar test results. Also fewer of the chiropractic than homoeopathy students became drop-backs and academic exclusions (by implication then less students who would require costly institutional support in order to become successful) with the same second test performances. This phenomenon held true over all five the first-year subjects investigated. As mentioned on a number of occasions in this

discussion, this apparent difference between the two groups of classmates would need further investigation.

As with the demonstrated relationship between first test results and outcome at the end of the first year (Section 2.1), no direct comparisons of the results discussed in this section of the research could be made with other published studies. The available literature only produced the two studies mentioned before (Van Overwalle 1989; Croen *et al.* 1991), both of which were too dissimilar to lead to any worthwhile comparisons.

The results discussed in this section of the present research gave an indication of the existence of a strong relationship between second test results and outcome at the end of the first year of studies.

6.3.2 CAN A LOGISTIC REGRESSION MODEL THAT WILL IDENTIFY THE FRESHMEN AT RISK OF FAILURE BE ESTIMATED FROM TEST 2 RESULTS?

A model that can utilize second test results in the freshman year to correctly identify the student at risk of failing could have two very important applications. Firstly, identification of the “at risk” students by the middle of the year would still allow time to provide institutional support mechanisms to try and save such students. Secondly, if any support mechanisms were instituted after the same students had been classified as “at risk” on the basis of their first test results, a model developed from second test results might now also be useful for evaluating the effectiveness of such support mechanisms.

In Section 6.2.1 a relationship emerged between second test results and outcome at the end of the first year. The purpose of the present study was to further investigate the

predictive relationship between the second test results and outcome at the end of the first year of studies in chiropractic and homoeopathy.

The logistic regression model developed by means of backward elimination for the estimation of the probability that $Y = 1$ (the probability that the student fails to succeed) included all five the predictor variables (Table 19, Figure 52). The results of this analysis thus indicate that second test results in physiology, anatomy, biology, chemistry and physics discriminated well between non-successful and successful freshmen. The overall percentage of correct classification was 85.94%, which indicates that the estimated logistic regression model is reliable. Different diagnostic procedures (Figures 53 to 55) conducted on the prediction model indicated that the estimated logistic regression model fitted the data well.

In the previous sections it was mentioned that, on average, first test results in physics did not appear to be a strong indicator of students in need of support. By the second test results (Section 6.3.2) this trend could not be demonstrated again. As far as the predictive ability of the second test results are concerned, it is interesting to note that physics did survive the backward elimination process for the development of the estimated logistic regression model discussed in this section of the research (Table 19, Figure 52). However, the ability of an independent variable to explain the variability in the dependent variable is significant only if the associated P-value is less than the level of significance α . With α set at the 0.05 level of significance, Table 19 shows that $p < \alpha$ for four of the independent variables included in the optimum logistic regression models, namely physiology, anatomy, biology, and chemistry. That means that those four variables have the capacity to account for the variability in the dependent variable. Although the physics second test results were included in the estimated model, physics was only important at the $\alpha = 0.10$ level of significance. This finding might therefore be an indication that, although the standard of physics assessment had increased slightly by the time of the second tests, it was still lower than that of the other four first-year subjects included in the model. Unfortunately no published studies could be found to be compared with the present results.

The results reported here indicate that certain of the chiropractic and homoeopathy freshmen were at higher risk than others of not being successful at the end of the first year of study. Results from the logistic regression analyses suggest that a reasonably accurate predictive model can be developed that has an overall predictive accuracy of approximately 85.94%, which is considerably higher than that of the strong model developed in Section 6.2.2 from first test results and which had an overall predictive accuracy of approximately 80.82%. An equation (Figure 52) based on second-test results in physiology, anatomy, biology, chemistry, and physics significantly discriminated between those freshmen who would require support in order to be successful, and those who would be successful at the end of the first year of studies. Compared to the successful students (coded as 1), the group of students who would require support (coded as 2 and 3) would have lower scores in the second tests of these five first-year subjects.

As mentioned in the discussion of the estimated logistic regression models developed from first test results (Section 6.2.2), an apparently accurate predictive model developed from one set of data might not necessarily fit a different set of data drawn from the same universe. The present estimated logistic regression model developed from the data of all chiropractic and homoeopathy freshmen who registered between 1989 and 1995 would therefore have to be validated on another set of data from the chiropractic and homoeopathy students before it could be used as a tool for an early identification of freshmen in need of support.

6.3.3 CAN A LOGISTIC REGRESSION MODEL ESTIMATED RETROSPECTIVELY FROM TEST 2 RESULTS BE USED FOR THE EARLY IDENTIFICATION OF FUTURE AT RISK FRESHMEN?

The estimated logistic regression model developed retrospectively from the second test results of all chiropractic and homoeopathy students who had registered between 1989 and 1995 (Table 19, Figure 52), had a high overall predictive accuracy of 85.94% and was therefore reasonably reliable. However, before this model could be used in any diagnostic capacity for the identification of the student in need of institutional support, the model had to be validated. This was done by making use of the second-test results of all chiropractic and homoeopathy freshmen who registered in 1996 and 1997.

Figure 57 indicates that the model has a high specificity of 92.44%. This implies that the model could correctly identify more than 90% of those freshmen that would be successful at the end of the first year. This value is a considerable improvement on the specificity of the previously discussed predictive model developed from first test results (Figure 31). It appears as though it gets “easier” as the year progresses to be able to correctly identify the freshmen who will potentially be successful at the end of the year.

In Section 6.2.3. it became apparent (Figure 31) that the specificity of the model developed from first test results could be increased considerably from 59.26% to 78.38% by omitting the chiropractic 1996 results. This cohort of freshmen apparently was successful at the end of the year despite “lower” performance in the first test series. It is of interest to note that this trend is not apparent for the second test results. With a specificity of more than 90% it appears as though all freshmen who were eventually successful at the end of the year had performed as such by the second test. This fact is of considerable importance to academic planners at tertiary level institutions. Aitken (1982) stated that academic performance is assumed to directly affect withdrawal decisions not

only because institutions set a minimum level of academic performance which must be met in order for the student to remain in the institution, but also because the institutional measure of academic performance provides a direct message as to how the student is doing relative to both the student's peers and an absolute standard. If success breeds success, then the opposite must also be true. Once a student realizes that he/she is not coping, he may get despondent and do even worse. This result would also have an effect on his psychological state. Whatever the reason for the chiropractic students to apparently overcome initial lower performance and stay focused, would need to be urgently investigated. A possible explanation for this phenomenon might be that the chiropractic programme has such a large number of applicants for relatively few places. Once students have "fought" their way into the programme they might be reasonably sure of their career choice and be determined to qualify. Tinto (1975) suggested that potentially important compensatory interactions among different constructs could occur in the whole process of student persistence. Tinto (1975) hypothesized, for example, that in terms of influence on persistence, a high level of commitment to the goal of graduation may tend to compensate for a low level of commitment to the institution, and vice versa. The apparent difference between these constructs in the two programmes chiropractic and homoeopathy would need to be further investigated. As was suggested before, a starting place for such an investigation might be to conduct climate studies in the two departments.

Although the specificity of the present model is very high, it must, however, be stressed again that the present research was not aimed primarily at the identification of the potentially successful students. This investigation was an attempt to identify those freshmen who would need institutional support in order to have a successful outcome at the end of the first year of tertiary studies. The sensitivity of the models was therefore seen as of greater value than the specificity. For the present model, Figure 56 shows a sensitivity of 67% which indicates that the model is able to correctly identify only two-thirds of the eventually non-successful students. Even an increase of sensitivity to 80.56% after an arbitrary increase in the cut-off estimated probability of the event occurring from 0.5 to 0.65 (Hosmer & Lemeshow 1989), indicated a sensitivity much

lower than the 97.62% of the model developed from first test results. As no other studies could be found which addressed this problem, no meaningful comparisons could be drawn with other results. In Section 6.2.3 the Croen *et al.* (1991) study was mentioned as the only study which reported the percentage of "at risk" students that could be identified after the three-month examination of first year medicine. The authors indicated a correct identification of 77% of such students, a figure that is more in accord with the 67% to a possible 80.56% found in the present study. However, as explained before, it is not possible to meaningfully compare the two studies.

As far as predictive errors are concerned, the model validation indicated a Type I (False negative) rate of 14.29% (Figure 56). This means that only approximately 14% of the students who were actually successful at the end of the first year were predicted as being not successful. This figure is now much lower than the 34% false negative predictions of the model developed from first test results (Figure 30). However, as was mentioned in Section 6.2.3, this cannot be seen as a serious predictive error. Many chiropractic and homoeopathy students who passed the first year were still unsuccessful in the following years (e.g. Tables 4, 7). It can therefore only be of benefit to such (perhaps) borderline academic students and might prevent their attrition in later years if they can be identified as possibly being at risk, and therefore be granted the opportunity of institutional support of whatever nature.

It is important to note that the Type II error (false positive) of the model developed from second test results is high (33.33% reduced to 19.44% with an increase in the cut-off estimated probability from 0.5 to 0.65)(Figure 56). This indicates that the present model missed too many of the potentially "at risk" freshmen to be of value as a management tool for the early identification of the student who might require support.

A comparison between the models developed from first test and second test results produced some very interesting and potentially important results. As can be seen from the high sensitivity (92.8% to 97.62%) and very low Type II error (false positive) values of the model developed from first test results (Figure 29), these results could be very useful for the early identification of the students who are at risk academically and

therefore of those students who would require institutional support. Such required support could then be provided at an early stage in the year to combat high attrition rates.

In contrast, although the model developed from second test results has a much lower sensitivity than the first model, it has a much higher specificity, i.e. 92.44% (Figures 31, 56). Together with the low Type I error (false negative) rate of 14.29% (Figure 56), it appears as though the model developed from second test results is much better for the prediction of those freshmen who will be potentially successful at the end of the year.

In the next section the same data will be subjected to discriminant analyses in order to further investigate the ability of first and second test results to distinguish between successful freshmen and those freshmen who would require support in order to complete the first year successfully.

6.4 STUDY 4 : DISCRIMINANT ANALYSIS

The investigations conducted in Studies 2 and 3 (Sections 6.2 and 6.3) provided a very strong indication that first as well as second test results in the first year of the chiropractic and homoeopathy programmes were useful discriminators between successful freshmen and those that would need support in order to be successful. As the reviewed literature provided no studies that had investigated the problem of freshman attrition in a similar manner, discriminant analyses were also performed in an attempt to develop alternative predictive tools from first and second test results and so to put the promising results of the previous sections further to the test.

6.4.1 CAN DISCRIMINANT ANALYSIS PROCEDURES BE UTILIZED TO DIFFERENTIATE BETWEEN SUCCESSFUL AND UNSUCCESSFUL FRESHMEN ON THE BASIS OF THEIR TEST 1 RESULTS?

The most parsimonious discriminant analysis model developed from first test results included four predictor variables (Table 20). As with the estimated logistic regression model developed from first test results, the physics results were again excluded from the model. The finding previously mentioned that the first physics test results were apparently poor indicators of outcome at the end of the year and that these tests may possibly have been of a lower academic standard than that of the other four first-year subjects were thus supported by this analysis. The other four predictor variables namely physiology, biology, anatomy, and chemistry first test results were all statistically significant in determining group membership.

The usefulness of the discriminant analysis model (Figure 58) for the early identification of the student in need of support was indicated by the diagnostic measures utilized to test the predictive model. These measures show that the estimated discriminant function had a high overall percentage of correct classification of 80.6% (Table 21) and that the criterion used to define group membership was objective.

Short of testing the model on a different set of data as was done with the logistic regression analysis, but still in order to build the best possible model for classifying new cases in the future, the classification into the two groups of the grouping variable was conducted firstly on all the original cases, and then cross-validated by means of the leave-one-out method. Table 21 shows both the correct classifications for the original as well as for the cross-validated classifications. These data indicate that the overall percentage of correct classification was 80.6% using the original classification and 79.3% with the cross-validated classification. The predictive ability of this model is thus almost identical to that of the estimated logistic regression model developed in Section 6.2.2, which had

an overall predictive accuracy of approximately 80.82%. This result is very encouraging because it implies that two different statistical methods individually indicated that first test results in the same four subjects, namely physiology, biology, anatomy, and chemistry, were good (and very early) indicators of the freshmen in need of support.

The data in Table 19 also indicate that the specificity (i.e. the ability of the model to correctly identify those students who would be successful) was 82.3% for the original classification and 81.4% for the cross-validated classification. Although this figure is much higher than the 59.26% of the logistic regression model discussed in Section 6.2.3 (Figure 31), two facts need to be kept in mind in this regard. Firstly, it was indicated that the specificity of the logistic regression model was decreased by the 1996 chiropractic results (Figure 31) and that the omission of this group from the calculation increased the specificity of the model to 78.38%, which is reasonably close to the value indicated for the discriminant model (Table 21). Secondly, it must also be remembered that the specificity of the logistic regression model was a validated value, in other words the model was tested on a fresh set of data. In the present model the cross-validated value was slightly lower than that of the original classification (81.4% as opposed to 82.3%), but the leave-one-out estimates might still be on the optimistic side and would need to be validated on a new set of data from the same group of students.

The results of the discriminant analysis reported here again indicate that certain of the freshmen were at greater risk than others of not being successful at the end of the first year of studies. It was the ability of the model to correctly identify the potentially "at risk" group of freshmen that was of most importance to this researcher and the sensitivity of the model was thus seen as of more value than the specificity. Table 21 indicates the sensitivity of the original classification to be 78.1% and that of the cross-validated sample as 76.0%. This value indicates a good model, but is not as robust as the more than 90% sensitivity of the validated logistic regression model (Figure 30) discussed in Section 6.2.3.

The results from the discriminant analyses performed in this section of the research provided strong support for the usefulness of first test results for the accurate and early

discrimination between the successful freshmen and those who would require support in order to be successful.

6.4.2 CAN DISCRIMINANT ANALYSIS PROCEDURES BE UTILIZED TO DIFFERENTIATE BETWEEN SUCCESSFUL AND UNSUCCESSFUL FRESHMEN ON THE BASIS OF THEIR TEST 2 RESULTS?

The most parsimonious discriminant analysis model developed from second test results included four predictor variables (Table 22). It is interesting to note that again the second Physics test results were excluded from the model whilst the second test results of the other four predictor variables namely physiology, biology, anatomy, and chemistry were all statistically significant in determining group membership. This result supports the findings as indicated in the diagnostic procedures of the estimated logistic regression model developed from second test results (Table 21). Where the other four predictor variables were highly significant in their capacity to account for the variability in the dependent variable Y, physics was important only at the $\alpha = 0.10$ level of significance.

The usefulness of the discriminant analysis model (Figure 59) for the early identification of the student in need of support was indicated by the diagnostic measures utilized to test the predictive model. These measures indicate that the estimated discriminant function has a high overall percentage of correct classification of 84.3% (Table 23) and that the criterion used to define group membership was objective.

As explained in Section 6.4.1 the discriminant analysis model was not validated by testing the model on a different set of data drawn from the same universe. However, in order to still build the best possible model for classifying new cases in the future, the classification into the two groups of the grouping variable was done firstly on all the

original cases, and then cross-validated by means of the leave-one-out method. Table 23 shows both the correct classifications for the original as well as the cross-validated classifications. These data indicate that the overall percentage of correct classification was 84.3% using the original classification and 82.9% with the cross-validated classification. This value is very good for a predictive model, but not quite as high as that of the estimated logistic regression model developed in Section 6.3.2 that had an overall predictive accuracy of 85.94%. This result is again very encouraging because it implies that two different statistical methods indicated that second test results were good indicators of those students in need of support.

The data in Table 23 indicate that the specificity (i.e. the ability of the model to correctly identify those students who would be successful) was 82.6% for the original classification and 80.9% for the cross-validated classification. This value is encouragingly high, but still much less than the 92.44% achieved by the logistic regression model using the same predictive variables. The high specificity of the logistic regression model must also be seen against the fact that that was already a validated value whereas the present model had not been tested on a new set of data from the same universe. Even the cross-validated specificity of the present model might thus still be optimistic. Although the logistic regression model appears to be superior for the identification of the successful student, both models delivered very encouraging results for the use of second test results as predictors of outcome at the end of the first year of studies.

As indicated before, the sensitivity, or the ability of the predictive models to correctly identify the student at risk of failing and thus in need of support measures, must be seen as of more value to a tertiary institution. Table 23 indicates the sensitivity of the discriminant analysis model with the original classification to be 87.3% and with the cross-validated classification to be 86.5%. These values indicate a very good model and are higher than the values indicated by the corresponding logistic regression model (Figure 56). However, it must be borne in mind that the logistic regression value was for the validated model whilst the present values were, at best, for a cross-validated sample.

As with the results reported in Section 6.4.1, the important conclusion that could be drawn from the discriminant analyses performed in this section of the research is the strong support it delivered for the use of second test results in making a distinction between those students who would be successful and those students who would require institutional support in order to be successful at the end of the first year of studies in chiropractic and homoeopathy.

Two powerful statistical measures have each delivered a very strong predictive model firstly from first test results and also from second test results. The use of early assessments in the freshmen year as measures of academic integration into the programmes chiropractic and homoeopathy can no longer be denied.

CHAPTER SEVEN

RECOMMENDATIONS

In this thesis it was shown that both first and second test results in the freshman year of the chiropractic and homoeopathy programmes were strong predictive measures for the early identification of the student at risk of failing. A very powerful and useful tool in the management of student attrition from tertiary institutions was thus developed. An unexpected "extra" advantage that emerged from this research was the fact that the first and second test results appeared to have different predictive strengths for the identification of those freshmen that would need support in order to be successful and those that would be successful without needing costly institutional support.

The first test results for example appeared to be very useful for the correct identification of the student in need of support and less strong in the identification of the potentially successful students. The logistic regression analyses delivered an excellent model able to correctly identify almost all eventually non-successful freshmen and thus "missed" almost none of this at risk group. The development of such a strong model is even more important when seen against the fact that this information will be available so early in the year. A departmental secretary can read the first test results into a simple computer programme and the head of department will have an indication of the predicted academic outcome of every one of his/her students early in April of the freshman year. That leaves enough time for whatever remedial/support processes are to be instituted to positively affect the academic outcome of such a freshman.

The second test results, on the other hand, delivered a logistic regression model which was better at identifying the successful freshmen than it was at identifying the at risk freshmen. Again an excellent model was developed which was able to identify most of the successful students and thus missed only a low percentage of this group. Again the

results can be obtained in the manner as mentioned above with a departmental secretary reading the results into a simple programme that will calculate a student's probability of not being successful. By using this model in tandem with the previous one, an educational manager will now be able to evaluate the effectiveness of support measures. For example, once the freshmen in need of support have been identified from the first test results, the necessary remedial/support mechanisms should then be implemented. The model which utilizes the second test results will then indicate those students who are potentially successful. If a student has moved from the at risk group to the potentially successful group, then this will be an indication that the support measures were effective. If the student is still not identified as potentially successful, then the implemented support mechanisms might not be effective, or the remedial/support measures should be continued for longer as there would still be enough time left for additional remedial/support interventions to have a positive effect on attrition rates.

Of importance also to note is the fact that the discriminant analysis model developed from second test results was very strong in the identification of the at risk freshman. Should this model be used together with the logistic regression model, it would also give a head of department an extra indication of those students who are still at risk after the second test series, or of possible "new" cases. Again there is still enough time left of the year for remedial/support interventions to have a positive effect on attrition rates.

Of paramount importance in the development of these predictive tools is the fact that an entirely objective identification method has been developed. In the present South Africa special care has to be taken not to discriminate against people on the basis of colour. The author does not agree with suggestions that support programmes should be mandatory for all previously disadvantaged students. Premature labeling as academically at risk could have serious results in that it could very easily become a self-fulfilling prophecy. With the ability to identify those students in need of support so early in the academic freshman year, applicants now do not have to be relegated to a "slow stream" simply on the basis of their colour or on the basis of possible previous academic disadvantage. With the availability of the predictive models, all students

selected into a programme can start the year together and a decision of which (if any) freshman that will need academic support can be made objectively on the basis of the proven academic integration of each individual freshman. The students indicated by the predictive models as at risk can then be tested to determine the type of support that will be of most value to them. Should a possible solution then be the decision to put some freshmen into a "slow stream" where two years will be needed to complete the first year, this decision can now be made objectively and such an opportunity should now be available to all at risk students – even the previously advantaged ones.

According to the theoretical models of attrition it might be possible to manage attrition at two interception points, i.e. firstly from pre-registration data, and secondly from post-registration data. Of these two possible intervention phases it would be very valuable to utilize the information available at the time of registration to select the "correct" and mostly successful cohort of students for an academic programme. It appears from the literature, however, as though the management of attrition in the pre-registration phase is too complex to allow for substantial reduction of attrition rates. This should, however, be an ongoing area of endeavour for educational researchers as it is important for tertiary institutions to provide higher education for those that deserve it, whilst keeping unit costs as low as possible by not providing access to students who do not have the potential to succeed. Research into better selection and evaluation methods of high school students for the scarce openings in tertiary programmes should thus go on continuously.

Pre-registration data might then, at best, be useful for screening purposes and institutions will have to focus on the post-registration period for any substantial reduction in attrition rates. It is a well-published fact that the addition of previously disadvantaged students increases attrition rates. So, once a tertiary institution has formulated the acceptance of its social obligation into a strategic decision to provide access to larger numbers of underprepared students, it should also accept responsibility for all the students allowed to register for the different programmes. A tertiary institution should not only provide quality education to all its students, but it should also ensure that all students are supported towards the successful completion of their studies.

An institution must be able to calculate the financial implications of enrolling a student into each one of the courses/programmes offered at that institution. Such cost calculations should include the financial implications of the remedial/support measures provided to potentially unsuccessful students. Individual tertiary institutions must then make informed decisions on whether they can afford to support the at risk students with costly support services. Such decisions will have to be based on sound data. In order to plan effectively, a comprehensive management information system is thus required. The author suggests that such an information system cannot be complete without repeating, for every programme in a tertiary institution, the investigations undertaken in the present research. Only once the problem of attrition has been quantified and described adequately for every programme in an institution, and models developed whereby the students at risk of failing could be identified objectively, will an institution have the necessary information base for a comprehensive strategic plan. The predictive models developed in this research provide the opportunity for educational management to identify the student in need of support at an early stage and to quantify and cost the student support that will be required to improve institutional attrition rates. Such calculated costs per programme can then be extrapolated to further years in order to provide an objective basis for financial planning and budget allocations.

An area that needs urgent research is the type, or combination of types, of remedial/support mechanisms that would be required to enable potentially unsuccessful or at risk freshmen to successfully complete their first year of studies. Support mechanisms should be geared at the specific problems of the individual student. Students identified as at risk should be tested as non-academic factors could also result in less than adequate academic performance. Post-registration support can take on many forms and can either provide assistance during the student's studies by means of support programmes, or by changing curricula in accordance with the student's preparedness level. This would, for example, allow students to proceed at different rates and by carrying different workloads. It should also include changes in approaches to teaching and learning. Support mechanisms should be geared towards assistance with note taking

and reading improvement, as well as assistance with study skills and helping students to change their study methods from 'surface' to 'deep' approaches. Helping students deal with stress and recognising mental problems should, however, also be an integral part of student support.

A number of support programmes specifically designed for South African conditions appeared to have had some success in reducing attrition rates. A serious problem perceived with most of these programmes is the fact that they often happen in isolation and are mostly add-on programmes to a specific tertiary programme. It is important that tertiary institutions understand that part of their responsibility to their students is that research into these support programmes is institution-driven and also financially supported. Any support programme implemented by the institution must be researched in order to determine its effectiveness in changing failure behaviour to success behaviour. Models such as the ones developed in this research can be employed in this regard.

Management of attrition in the post-registration phase should first and foremost be geared towards all students in the system and any sizeable reduction of attrition rates might only be achievable by improved teaching and learning strategies to all students. With the exception of a few isolated initiatives, most of the teaching strategies in use at South African tertiary institutions appear to be largely outdated. Lecturers will have to be brought up to date with the latest developments in teaching and learning so that they can change their approaches towards student-based active learning and directed self-learning. It is important that they also be able to provide supportive learning environments, and teaching that is successful with all learning styles. Tertiary institutions will thus have to understand and accept their responsibilities to the students that they enroll by ensuring that the necessary staff development takes place. The move towards student-based and resource-based learning is resource-intensive (at least initially) and institutional commitment to providing the necessary funds for this development will have to exist. Any change in lecturing approach should also be researched in order to determine the impact that this has on attrition and retention rates.

The current research has uncovered a number of differences between the chiropractic and homoeopathy programmes that would need further investigation. These differences appeared to be clear and consistent despite the fact that the students were still busy with their “pre-professional” studies and were thus treated as a homogeneous group by the lecturers in the basic sciences. For example, although the success rate at the end of all three the first years of study was low for both programmes, the chiropractic students were on average more successful than the homoeopathy students at the end of each year of study. It also became apparent that while the chiropractic freshman group size increased steadily over the years investigated the number of homoeopathy freshmen decreased dramatically. The research also indicated that the chiropractic students started outperforming the homoeopathy students from approximately the same year that the decline in homoeopathy numbers became apparent. A possible explanation for this phenomenon was put forward by the author as that the homoeopathy department was not attracting enough “quality” students. In order to ensure cost-efficient management of the Department of Homoeopathy as well as of the service department providing the basic subjects, this matter will have to be researched urgently.

A recurrent trend that emerged from the research was also the fact that the chiropractic students were apparently more successful than homoeopathy students were with the same test results (i.e. first and second tests in the freshman year). This observation emerged with both first and second test results in every one of the five first year subjects investigated. Also fewer of the chiropractic than homeopathy students became dropbacks and academic exclusions with the same first and second test results. By implication this would then mean that fewer of the chiropractic than the homoeopathy students would require costly institutional support measures in order to become successful. This phenomenon should be urgently investigated. Whatever influences are at work in the chiropractic department that are perhaps absent in the homoeopathy department and may enable some of the students to stay focused and committed to the goal of graduation, would need to be identified in order to either amplify such factors and/or develop them in the other department. Such a result could also have wider implications for other tertiary programmes.

Of interest to note also was the indication that many more homoeopathy than chiropractic students withdrew from the programme voluntarily, and did so even as late as the third year of studies. This trend will need further investigation. It is very difficult to establish retrospectively why students withdrew voluntarily from a programme. In some cases students had financial or health problems and in some cases they decided that they had made a mistake in their choice of profession. Some of the voluntary withdrawals might also have been academically linked in that students realized that they had no hope of passing a particular year. A prospective study should be planned in an attempt to determine the major reasons for voluntary withdrawals in order to assist selectors in their very difficult task. Exit interviews, and/or follow-up questionnaires might also shed some light on withdrawal behaviour.

A number of points of concern about specifically the homoeopathy department have been mentioned above. These include a serious drop in freshman numbers, high voluntary withdrawal rates as late as the third year of study, and poor pass rates. In general the performance of the homoeopathy students was worse than that of their chiropractic classmates and the general decline in the above indicators started about three years after the start of the programme. It appeared as though there was a general lack of commitment to graduation manifesting in withdrawal behaviour.

The theories of attrition indicated that both the academic and social systems were important to student persistence and insufficient rewards from either of these two systems might lead to withdrawal decisions. Within the social system, the students would need to feel that their attitudes, interests, and personality dispositions were compatible with attributes and influences of the (departmental) environment (normative congruence). Students also need to be satisfied with their tertiary institutional experience in order to sustain commitment to the institution. The greater an individual student's level of social and academic integration, the greater the subsequent commitment to the institution and commitment to the goal of graduation, respectively. These commitments are seen to have a direct, positive influence on persistence. The attrition behaviour of the homoeopathy students and their poorer than expected academic performance, might be indications of

poor integration into the social environment of the department and thus an inability to sustain commitment to the institution and also to the commitment of graduation. The apparent problems in the Department of Homoeopathy should be urgently investigated and a starting point in such an investigation could be a climate study. This might shed light on reasons for the apparent lack of social and academic integration of the homoeopathy students.

Of serious concern was the high rate of attrition of particularly the first-year students in both the chiropractic and homoeopathy programmes. Urgent research is required to investigate the possibility that the academic threshold on entry might be too low and therefore allow too many underequipped or underprepared students into the programmes.

The present research was largely confined to the first year of study in the two six-year programmes chiropractic and homoeopathy. It is suggested that the problem of attrition be further investigated in the clinical years (years 4 to 6) of these programmes. As attrition rates still appeared to be high in the second and third years of study, attempts should also be made to develop prediction models from early test results in these two years for the identification of the student at risk of failure.

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